

# KIPS

ENTRY TEST SERIES

For All Kinds of Entry & Aptitude Tests

# BIOLOGY



- ▶ Quick Review of the Syllabus
- ▶ Highlighted Points
- ▶ Mind Map for every Chapter
- ▶ Hundreds of Practice Questions
- ▶ Diagnostic Test
- ▶ Sample Paper for Entry Test
- ▶ Chapter-Wise Exercises with Answer Keys



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- This diagnostic test is designed to help you to pinpoint the weak areas in your background. Sit aside 1 hour to take this test. Check your answers with those at the end of the test. Then evaluate yourself.

## DIAGNOSTIC TEST (BIOLOGY)

- (1) The one which is present in all living things
 

(a) Cell nucleus	(b) DNA or RNA
(c) Cell membrane	(d) Vacuole
- (2) The mechanism of stomatal movement is related to the branch of Biology called
 

(a) Taxonomy	(b) Physiology
(c) Morphology	(d) Anatomy
- (3) Maximum number of species of living things on earth are
 

(a) Algae	(b) Fungi
(c) Insects	(d) Protozoa
- (4) Variety among amino acids is produced due to
 

(a) $\text{NH}_2$ group	(b) $\text{COOH}$ group
(c) R group	(d) All of these
- (5) Primary structure of proteins determines
 

(a) Number of polypeptide chains involved
(b) Bending of polypeptide chains
(c) Amino acid sequence
(d) Coiling of polypeptide chains
- (6) The one which is not a globular protein
 

(a) Anti Rh-antibody	(b) Enzyme
(c) Myosin	(d) Haemoglobin
- (7) An enzyme which converts a dipeptide into separate amino acids is an example of
 

(a) Decarboxylase	(b) Hydrolase
(c) Oxidoreductase	(d) Transferase
- (8) Cellular digestion is associated with which organelle
 

(a) Mitochondria	(b) Golgi bodies
(c) Plastids	(d) Lysosomes
- (9) The unicellular organisms ingest large molecules into their cytoplasm from the external environment without previously digesting them. This process is called
 

(a) Diffusion	(b) Osmosis
(c) Phagocytosis	(d) Plasmolysis
- (10) Membranes of the grana are sites where
 

(a) Oxygen is stored.	(b) Food is stored
(c) Sunlight is trapped.	(d) $\text{CO}_2$ is stored.
- (11) The simplest of oxygen producing photosynthetic organisms are
 

(a) Algae	(b) Bacteria
(c) Cyanobacteria	(d) Chlamydomonas





# DIAGNOSTIC TEST

- (12) Protein coats of viruses are synthesized in  
 (a) Lytic cycle  
 (b) Lysogenic cycle  
 (c) Both a & b  
 (d) All of these
- (13) Mycoplasmas have been included in bacteria because  
 (a) Do not have a cell wall  
 (b) Are heterotrophic  
 (c) Lack membrane bounded organelles ✓  
 (d) Reproduce by binary fission
- (14) Yeasts reproduce asexually by forming  
 (a) Asci  
 (b) Basidia  
 (c) Both a & b  
 (d) Buds.
- (15) The one which can tolerate highest external osmotic pressure  
 (a) Algae  
 (b) Amoeba  
 (c) Fungi  
 (d) Bacteria
- (16) Locomotory structures are not found in which of the following group  
 (a) Amoebas  
 (b) Zooflagellates  
 (c) Ciliates  
 (d) Apicomplexans
- (17) The cell wall of oomycetes is chiefly composed of  
 (a) Chitin  
 (b) Cellulose ✓  
 (c) Lignin  
 (d) Proteins
- (18) One celled green protists are included in  
 (a) Monera  
 (b) Algae  
 (c) Slime molds  
 (d) Plants
- (19) Pick the odd one out  
 (a) *Psilophyton*  
 (b) *Rhynia* ✓  
 (c) *Cooksonia*  
 (d) *Psilotum* ✓
- (20) The one which is incorrect pair  
 (a) Sori - Indusium  
 (b) Arthropytes - Jointed  
 (c) Dichotomous - Vernation ✓  
 (d) Lycopods - Ground pries
- (21) Double fertilization occurs in  
 (a) All plants  
 (b) All seed plants  
 (c) Gymnosperms  
 (d) Angiosperms
- (22) Amphioxus is a  
 (a) Chordate  
 (b) Protochordate  
 (c) Lower chordate  
 (d) All of these ✓
- (23) Adult birds normally possess only one functional  
 (a) Ureter  
 (b) Ovary  
 (c) Lung  
 (d) Testis
- (24) Following possess bilateral symmetry as larva and radial symmetry as adult:  
 (a) Chordata  
 (b) Hydra  
 (c) Echinodermata  
 (d) Hemichordata
- (25) Which of the following are triploblastic and acoelomate?  
 (a) Sponges  
 (b) Annelida  
 (c) Platyhelminthes  
 (d) Aves





## DIAGNOSTIC TEST

- (26) Which of the following occurs in anaerobic respiration but not in aerobic respiration?
- Release of  $\text{CO}_2$
  - Reduction of NAD
  - Formation of ATP
  - Production of ethanol from acetaldehyde
- (27) Which of the following is the empirical formula of chlorophyll 'b'?
- $\text{C}_{55}\text{H}_{70}\text{O}_5\text{N}_4\text{Mg}$
  - $\text{C}_{55}\text{H}_{72}\text{O}_6\text{N}_4\text{Mg}$
  - $\text{C}_{55}\text{H}_{70}\text{O}_6\text{N}_4\text{Mg}$
  - $\text{C}_{55}\text{H}_{72}\text{O}_5\text{N}_4\text{Mg}$
- (28) How many moles of carbon dioxide are produced by complete oxidation of one mole of pyruvic acid?
- 1
  - 2
  - 3
  - 6
- (29) The food of hydra consists of
- Humus
  - Detritus
  - Dead microscopic animals
  - Small crustaceans
- (30) Hunger pangs usually begin \_\_\_\_\_ after the previous meal.
- 2-4 hours
  - 6-8 hours
  - 10-12 hours
  - 12-24 hours
- (31) If a plasmolysed plant cell is placed in water, the cell will
- Burst
  - Be killed
  - Be deplasmolysed
  - Show no change in it
- (32) The major constituent of blood plasma is
- Protein
  - $\text{NaCl}$
  - Water
  - Cholesterol
- (33) All of the following veins carry deoxygenated blood except
- Superior vena cava
  - Inferior vena cava
  - Hepatic vein
  - Pulmonary vein
- (34) The windpipe or trachea lies
- Dorsal to oesophagus
  - Ventral to oesophagus
  - Lateral to oesophagus
  - None of these
- (35) Scurvy and beri - beri are caused by the deficiency of
- Vitamin B and C
  - Vitamin B and D
  - Vitamin C and B
  - Vitamin A and B
- (36) Kangaroo rat most probably would be found in
- Tropical rain forest
  - Tundra
  - Grass land
  - Desert
- (37) The greatest diversity of animals in the lake is found in which one of the following zones?
- Limnetic zone
  - Littoral zone
  - Profundal zone
  - None of these
- (38) What is the characteristic feature of consumers?
- Autotroph
  - Heterotroph
  - Parasite
  - Saprophyte
- (39) What percentage of light reaching the earth is used in photosynthesis?
- 25 %
  - 10 %
  - 5 %
  - 1 %





# DIAGNOSTIC TEST

- (40) All of the following are involved in nitrification except  
 (a) *Nitrobacter* (b) *Nitrosomonas*  
 (c) *Rhizobium* (d) All of these
- (41) Competition between species will be greatest if they attempt to occupy the same  
 (a) Ecosystem (b) Community  
 (c) Habitat (d) Niche
- (42) In most ecosystems the greatest amount of energy flows through the  
 (a) Secondary consumers (b) Herbivores  
 (c) Carnivores (d) Decomposers
- (43) Which of the following relationship is NOT an example of symbiosis?  
 (a) *Rhizobium* and leguminous plants.  
 (b) *Marchantia* sporophyte and gametophyte ✓  
 (c) Algae and fungi in a lichen  
 (d) Mycorrhizal fungi and tree roots
- (44) Animals with greatest number of similarities are grouped together in a/an  
 (a) Phylum (b) Family  
 (c) Genus (d) Order
- (45) The one which is present in all aerobic species  
 (a) Cytochrome c ✓ (b) Cytochrome a  
 (c) Cytochrome a<sub>3</sub> (d) Cytochrome b
- (46) The structure which has been formed or modified from gill pouches in humans is  
 (a) Gills (b) Eustachian tube  
 (c) Middle ear (d) Lungs
- (47) The first eukarotes appeared about \_\_\_\_\_ years ago  
 (a) 1.5 billion (b) 2.5 billion  
 (c) 3.5 billion (d) 4.5 billion
- (48) According to Lamarck, evolution occurred as the result of  
 (a) Natural selection  
 (b) The theory of recapitulation  
 (c) Inheritance of acquired characters  
 (d) Over production
- (49) The disease in which transmembrane carrier for the chloride ion is not produced is  
 (a) Hypercholesterolemia  
 (b) Cystic fibrosis  
 (c) Severe combined immunodeficiency syndrome  
 (d) AIDS
- (50) The one which can break open a plasmid ring is  
 (a) Ligase enzyme ✓ (b) Primase enzyme  
 (c) Restriction endonuclease (d) ATP-ase enzyme
- (51) A genome is  
 (a) Appearance of an individual  
 (b) Genetic basis of few characters  
 (c) Full set of genes of an individual  
 (d) All of these
- (52) Genes will not be found in gene pairs in the  
 (a) Muscle cell of worm (b) Uterine cells of dog  
 (c) Sperm cells of frog (d) Guard cells of leaf





## DIAGNOSTIC TEST

- (53) The red green colour blindness is sex linked recessive condition in man. A father with normal vision and a color blind mother would expect to produce
- (a) Color blind sons and daughter with normal vision ✓
  - (b) Sons with normal vision and color blind daughters
  - (c) Color blind sons, colour blind daughters and daughters with normal vision
  - (d) Sons with normal vision, colour blind daughter and daughters with normal vision
- (54) Which one of the following stage preceeds mitosis during cell cycle?
- (a) G<sub>1</sub> phase
  - (b) S phase
  - (c) G<sub>2</sub> phase
  - (d) M phase
- (55) Which one of following syndrome is the result of meiotic non dysjunction?
- (a) Klinefelter's syndrome
  - (b) Turners syndrome
  - (c) Down's syndrome
  - (d) All of these
- (56) Which one of the following is correct sequence of stages of prophase 1 of meiosis
- (a) Diakinesis, diplotene, pachytene, leptotene, zygotene
  - (b) Zygotene, leptotene, pachytene, diplotene, diakinesis
  - (c) Leptotene, zygotene, pachytene, diplotene, diakinesis
  - (d) Pachytene, leptotene, diplotene, zygotene, diakinesis
- (57) In humans the number of tetrads formed during mitosis is
- (a) 23 ✓
  - (b) 46
  - (c) 0 ✓
  - (d) 4
- (58) The sequence of 3 bases on tRNA which is complementary to condon of mRNA is called
- (a) Gene
  - (b) Anticodon
  - (c) Code
  - (d) Codon
- (59) Which statement correctly describes the transcription of DNA?
- (a) It produces another DNA molecule
  - (b) It produces mRNA ✓
  - (c) It is a semi conservation process
  - (d) It occurs at surface of ribosomes
- (60) The basic structural unit of a chromosome is
- (a) The centromere
  - (b) Nucleosome ✓
  - (c) Telomere
  - (d) Histone
- (61) The first stage of development in which a cavity appears is the
- (a) Neurula
  - (b) Morula
  - (c) Gastrula
  - (d) Blastula
- (62) Exposure to low temperature stimulates plants to flower. This is called
- (a) Photoperiodism
  - (b) Thermotropism
  - (c) Vernalisation ✓
  - (d) Thermoregulation ✓
- (63) The cells present in testes and secrete testosterone are
- (a) Sertoli cells ✓
  - (b) Germinal cell
  - (c) Interstitial cells ✓
  - (d) Spermatocyte
- (64) The type of learning in which there is loss or decrease in response to repeated stimuli
- (a) Imprinting
  - (b) Habituation
  - (c) Latent learning
  - (d) Insight learning





## DIAGNOSTIC TEST

- (65) The one which causes contraction of wall of the uterus during and after birth
- (a) ADH
  - (b) MSH
  - (c) Oxytocin •
  - (d) Progesterone
- (66) The one which is a weed killer
- (a) IAA
  - (b) NAA •
  - (c) 2, 4-D ✓
  - (d) GA
- (67) Sleep movements are a type of
- (a) Turgor movements •
  - (b) Growth movements
  - (c) Tactic movements
  - (d) Paratonic movements
- (68) The one that stores calcium
- (a) Sarcolemma
  - (b) Sarcoplasm ✓
  - (c) Sarcoplasmic reticulum •
  - (d) Cytosol
- (69) Which one of the following is most likely to occur in an animal during winter?
- (a) Activation of sweat glands
  - (b) Dilation of skin blood vessels
  - (c) Panting
  - (d) Thermogenesis •
- (70) Sebum produced from sebaceous glands in a mammal helps in
- (a) Protection against micro organisms •
  - (b) Temperature regulation
  - (c) Excretion
  - (d) All of these



KIPS ENTRY TEST SERIES

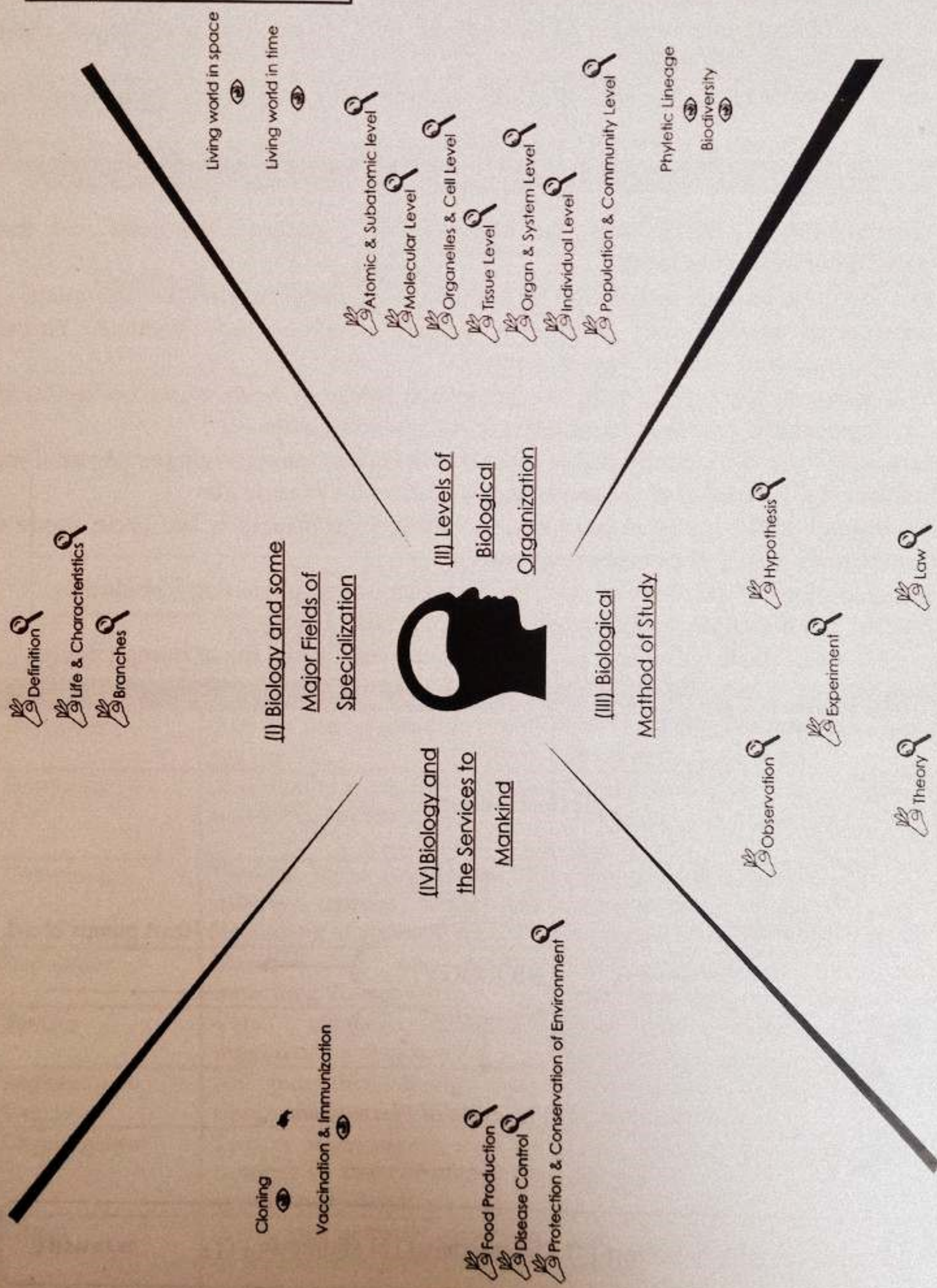
# Part - I

KIPS PUBLICATION



# Chapter 1

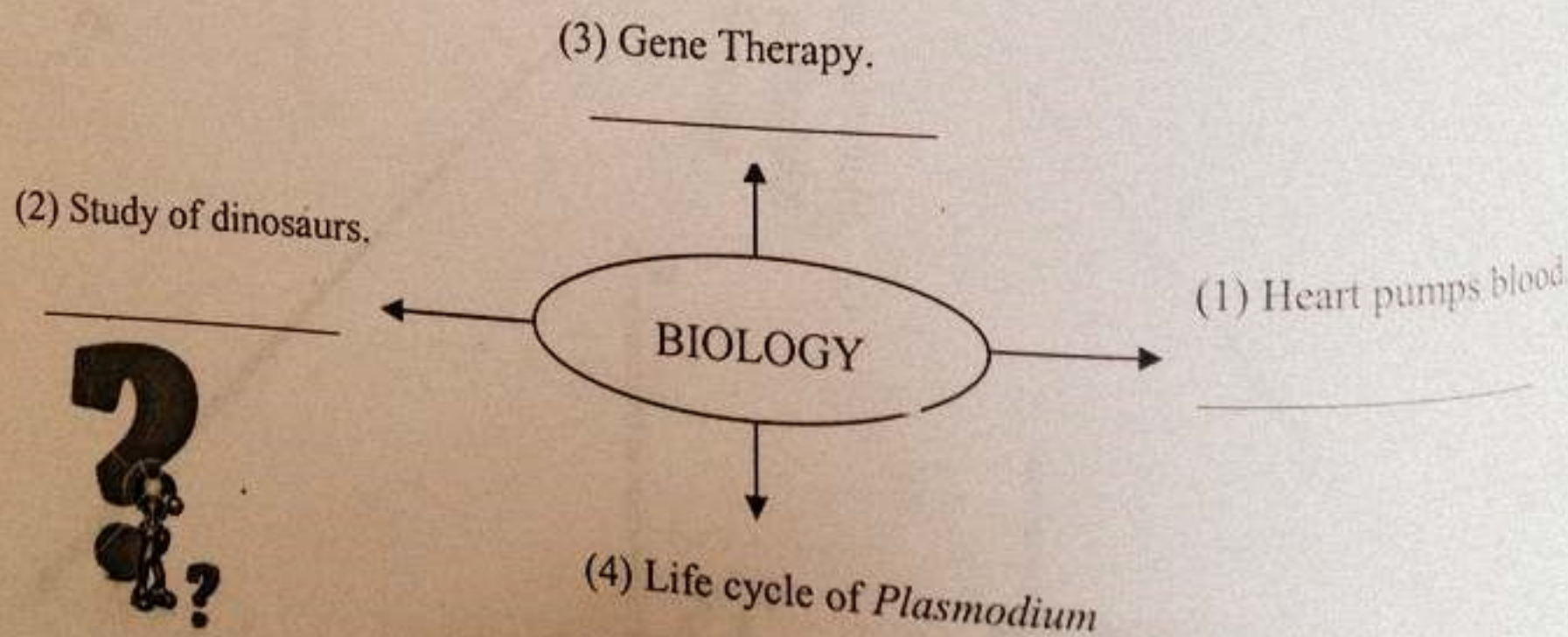
## INTRODUCTION





## BIOLOGY AND SOME MAJOR FIELDS OF SPECIALIZATION

- "Biology is the scientific study of living organisms."
- The word Biology is composed of two words: 'Bio' means 'life' and 'Logos' means thought, reasoning or study.
- "Life is a set of characteristics that distinguish living organisms from non-living things."
- Some of the important characteristics are metabolism, growth, reproduction, respiration etc.
- Molecular biology deals with the structure of organisms the cells and their organelles at molecular level.
- Environmental biology is the study of organisms in relation to their environment.
- Microbiology is the study of microorganisms which include Bacteria, Viruses, protozoa, and microscopic algae and fungi.
- Fresh water biology deals with the organisms living in fresh water bodies, along with physical and chemical parameters of these water bodies.
- Marine biology is the study of life in seas and oceans, along with the physical and chemical characteristics of the sea acting as a factor for marine life.
- Parasitology is the study of parasites, including their structure, life cycle, mode of transmission, and host parasite relationship.
- Human biology is the study of man, including anatomy, physiology, evolution, genetics, cell biology and ecological studies of human beings.
- Social biology deals with the social behavior and communal life of human beings.
- Biotechnology deals with use of living organisms, systems or processes in manufacturing and service industries.



Answers: (1) Physiology (2) Palaeontology (3) Biotechnology (4) Parasitology



**BIOELEMENTS**

- "The elements which are used in formation of various chemical compounds from which living organisms are made are called bioelements."
- Out of 92 naturally occurring chemical compounds, only 16 are found to be bioelements and out of these 16 only six bioelements account for 99% of the total mass of human body.

**Percentage Composition Of Bioelements By Mass Of A Human Being**

FORMULA	ELEMENT	PERCENTAGE
OCHNCaP	Oxygen (O)	65%
	Carbon (C)	18%
	Hydrogen (H)	10%
	Nitrogen (N)	3%
	Calcium (Ca)	2%
	Phosphorous (P)	1%
KSCISMFe	Potassium (K)	0.35%
	Sulphur (S)	0.25%
	Chlorine (Cl)	0.15%
	Sodium (Na)	0.15%
	Magnesium (Mg)	0.05%
	Iron (Fe)	0.004%
ZIMCu	Copper (Cu), Manganese (Mn), Zinc (Zn), Iodine (I)	Traces

**LEVEL OF BIOLOGICAL ORGANIZATION**

Biological organization can be divided into following levels:

LEVEL	DEFINITION	FEATURES
Biosphere	Part of earth inhabited by living organisms.	Extends 8-10 Km both below and above surface of earth
Ecosystem	A community together with its non-living surroundings.	Largest unit. Involving living and non-living components.( self sustaining)
Community	Two or more populations of different species living and interacting in the same area.	Dynamic collection of organisms, Changes more drastic in small communities.
Population	Members of one species inhabiting the same area	Same species, Same area, Same time, Same resources.
Species	Very similar, potentially interbreeding organism.	Basic unit of classification of biological organization.
Multicellular Organism	An individual living thing composed of many cell.	Coordination is present between different systems.
Organ System	Two or more organs working together in the execution of a specific body function	Less definite in plants than animals
Organ	A structure normally composed of several issue types that form a functional unit.	Less definite in plants than animals.





# Chapter 1

## Introduction

Tissue	A group of similar cells that perform a specific function	Cells similar structurally and functionally
Cell	The unit of life.	Unicellular organism with single cell, Multicellular organism with many cells.
Organelle	A sub- cellular structure that performs a specific function.	Comparable to organ of body, Less number & kind in prokaryote as compared to eukaryote.
Micromolecules & Macromolecules	A combination of atoms	Micromolecules: less molecular weight and macromolecules with high molecular weight.
Atom	The smallest particle of an element that retains the properties of element	Hydrogen, Carbon, Nitrogen, Oxygen.
Subatomic Particle	Particle that make up an atom	Proton, Neutron, Electron.

### Molecular Level

The atoms of different or same elements combine with each other through ionic or covalent bonding to produce compounds, this stable form is called a molecule.

- Molecules with lower molecular weight are called micromolecules e.g.,  $\text{CO}_2$  and  $\text{H}_2\text{O}$ .
- Molecules with high molecular weight are called macromolecules like starch and proteins.
- Organic molecules are molecules essentially containing C and H.
- Inorganic molecules are molecules that do not contain C and H together in a molecule.

### Organelles And Cell

- Cell is the basic structural and functional unit of living organisms.
- Unicellular organisms consist of a single cell e.g., bacteria and most protists.
- Multicellular organisms consist of more than one cell, mostly billions and trillions e.g., most of the fungi, plants and animals.
- An organelle is structure within the cell that perform specific function e.g., mitochondria, ribosome, endoplasmic reticulum.
- Arrangement of organelles speaks of the division of labor within the cell.
- Prokaryotes have only limited number and type of organelles
- Eukaryotes have greater number and kind of membranous organelles.

### Population

A population is a group of living organisms of same species located in the same place at the same time.



**Community**

- Population of different species (plants and animals) living in the same habitat form a community.
- Any smaller change in a *simple community* can have a drastic and long lasting effects, while it may be hardly noted in a larger and *complex community*.

**Biome**

- A large regional community primarily determined by climate is called a biome.
- Biomes are named on the basis of:
  - Major plants: e.g., forest ecosystem, grass land ecosystem
  - Major features of ecosystem: tropical rain forest, temperate deciduous forest.

**Biodiversity**

"Total number and variety of species in a place is called biodiversity."

**Phyletic Lineage**

"An unbroken series of species arranged in ancestors to descendent sequence with each later species having evolved from one that immediately preceded it is called phyletic lineage."



(1) Bioelement with highest Percentage?

(2) Basic unit of ecology?

(3) Inorganic molecules are micro or macro?

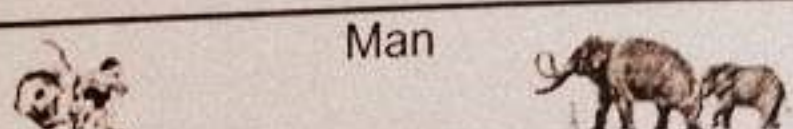

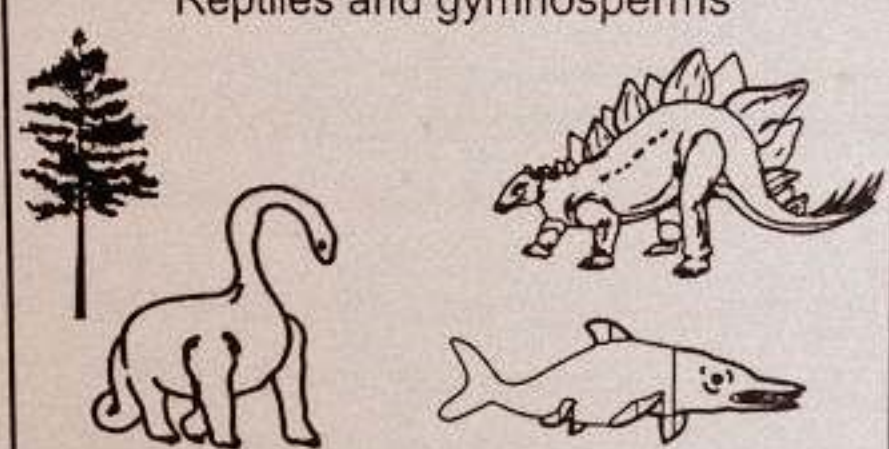

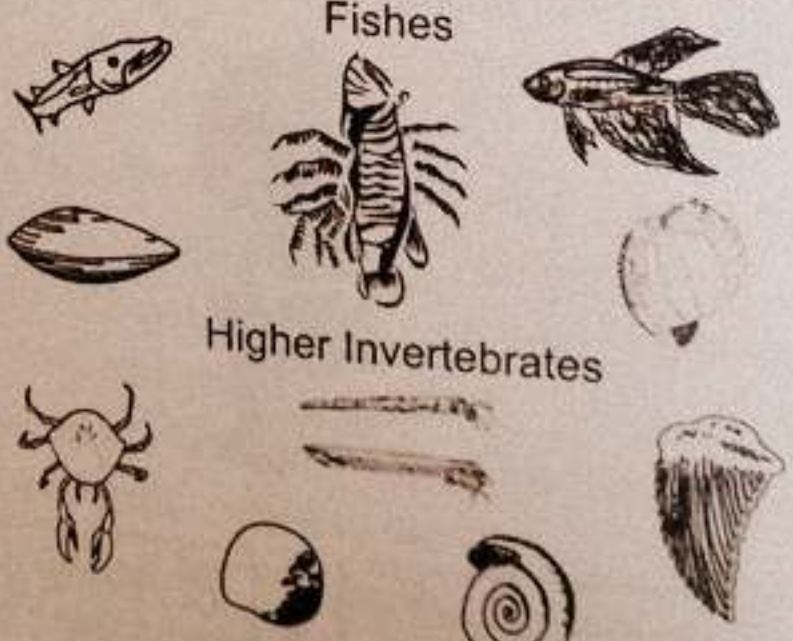
(4) Basic structural & functional unit of life?

(1) Oxygen (2) Ecosystem (3) Micromolecules (4) Cell

ANSWERS:



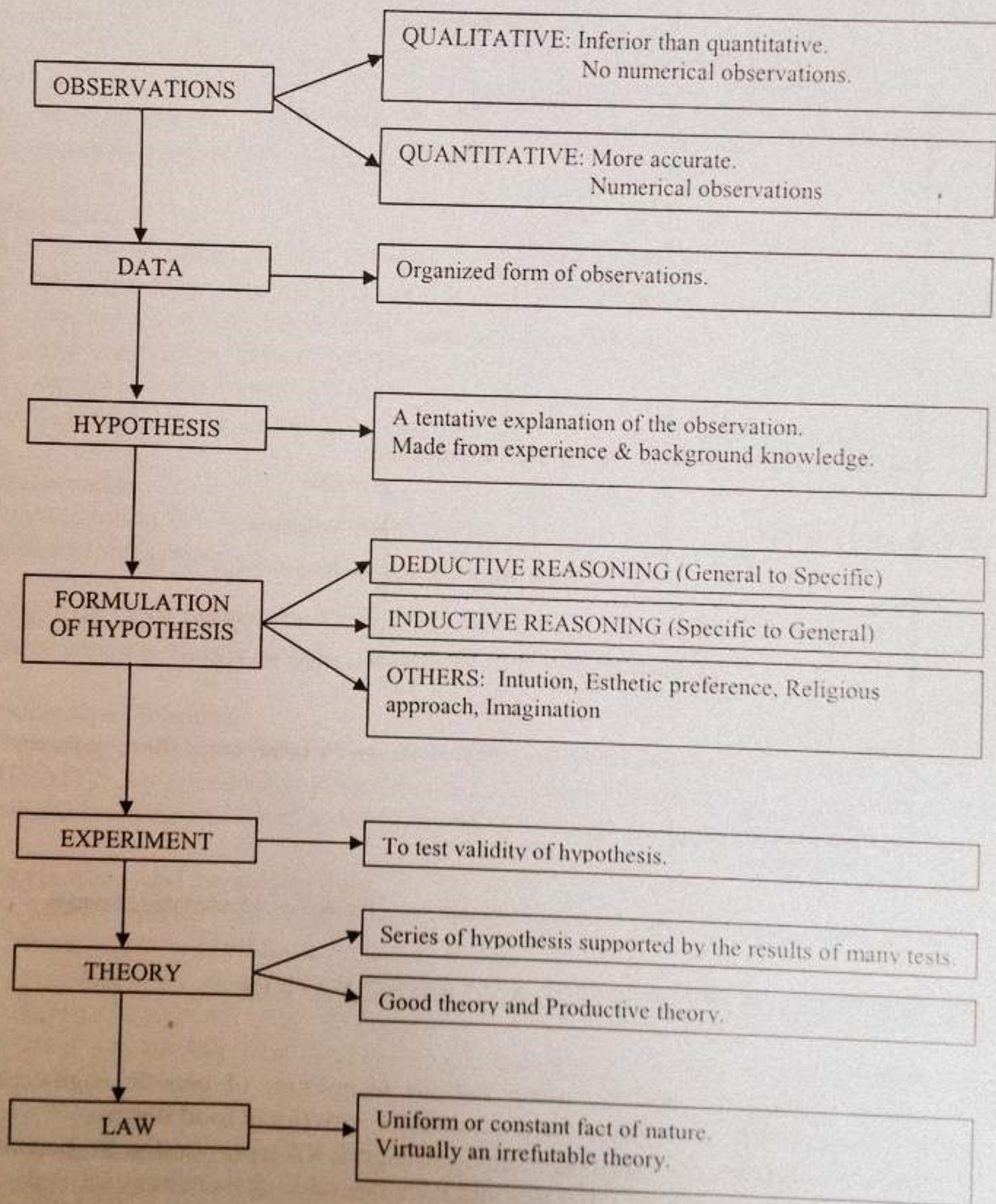
# GEOLOGICAL TIME CHART

ERA	PERIOD	CHARACTERISTIC LIFE	TOTAL ESTIMATED TIME IN YEARS
CENOZOIC	QUATERNARY	Man 	1,200,000
	TERTIARY PLIOCENE MIOCENE OLIGOCENE EOCENE PALEOCENE	Mammals and Modern Plants 	65,000,000
MESOZOIC	CRETACEOUS JURASSIC TRIASSIC	Reptiles and gymnosperms 	225,000,000
PALAEOZOIC	PERMIAN CARBONIFEROUS	Amphibians and lycopods 	145,000,000
	DEVONIAN SILURIAN ORDOVICIAN CAMBRIAN	Fishes Higher Invertebrates 	440,000,000
	PROTEROZOIC	Primitive Invertebrates and algae	570,000,000
	ARCHAEN	Archaeobacteria	945,000,000
			1,320,000,000
			1,735,000,000
			3,000,000,000

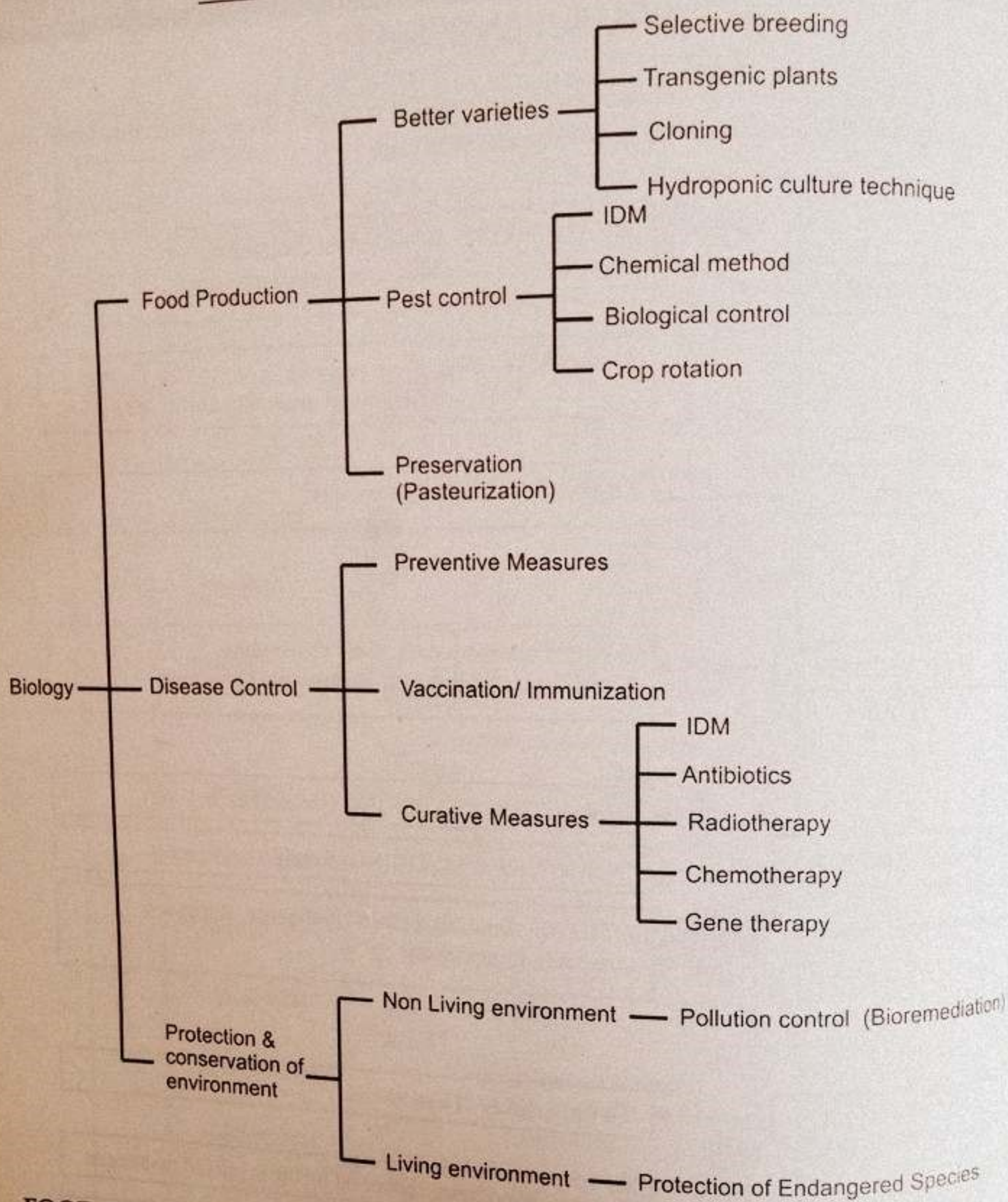


BIOLOGICAL METHOD

- Biological sciences have a set methodology and it is based on experimental inquiry.
- Following are the components of biological method:







### FOOD PRODUCTION, PROTECTION AND PRESERVATION

#### Production

- Principles of Genetics and by using various techniques of genetic engineering genetic engineers have developed new and better varieties of food items.
- Transgenic plants are the plants containing foreign DNA incorporated in their cells and thus are more resistant to diseases and have desirable characteristics.





- Hydroponic culture technique is a technique which is used to test whether a certain nutrient is essential for the growth and survival of plant or not.

### Cloning

- Production of genetically identical copies of organisms/ cells by asexual reproduction is called cloning.
- It is a technology used for achieving eugenic aims.
- A cell or an individual and all its asexually produced offspring is called a clone.
- The first organism being cloned was a sheep.
- Human cloning, which aims to serve as transplant donor source, is facing a great controversy through out the world.

### Protection

- Chemical fungicides and insecticides (pesticides) can be used.
- Disadvantages of chemicals are toxicity problems in human beings, environmental pollution and insect resistance.
- The method by which pests are destroyed by using some living organisms that compete with or even eat them up is called biological control.
- Advantage is that hazards of chemical pesticides are not there in biological control.

### Preservation

Pasteurization is a technique, developed by Louise Pasture, is used for preservation of milk and milk products.

### DISEASE CONTROL

Three prong actions is usually taken against the disease control.

#### Preventive Measures

These are employed before the occurrence of that disease. e.g., against AIDS and HEPATITS, by preventing oneself from contaminated needle prick, contaminated blood transfusion, sharing of surgical blades and other instruments.

#### Vaccination And Immunization

- Edward Jenner first developed the technique of vaccination and derived the name from 'vacca' a Latin name for cowpox pus.
- Number of the diseases can be controlled by vaccination e.g., measles, mumps, polio, tuberculosis, polio, Hepatitis A and B.
- Small pox has been totally eliminated from the world by use of vaccination.

#### Drug Treatment

- Drugs like antibiotics are used to kill bacteria; however some of the bacteria may develop resistance against various antibiotics.



- Radiotherapy is used against cancer. Cancerous part is exposed to short wave radiation from radioactive material repeatedly at regular interval.
- Chemotherapy is also used in treating the cancer. It involves administration of certain anti cancerous chemicals to the patients at regular interval which can destroy cancerous as well as normal cells.
- Gene therapy is a technique that repairs the defective genes by isolating the normal gene and inserting it to the host through bone marrow cells is called gene therapy.

### PROTECTION AND CONSERVATION OF ENVIRONMENT

- Vast and rapid industrialization has destroyed our environment, by adding tons of toxic and even carcinogenic industrial waste and harmful chemicals directly in atmosphere in rivers and other water bodies.
- Heavy metals like lead from automobiles, chromium from tanneries are playing havoc to man.
- Removal or degradation of environmental pollutants or toxic materials by living organisms is called bioremediation and can play a vital role in prevention of environmental pollution.



(1) Deduction is made after?

(3) Control of aphid by wasp is?

(5) Which technique is used by astronauts to grow vegetables?

(2) Proved form of theory is?

(4) Is vaccination preventive or curative measure?

(1) Hypothesis (2) Law (3) Biological control (4) Preventive (5) Hydroponic culture technique

Answers:





## ----- VALUES -----

Property	Value
Oxygen	65%
Carbon	18%
Hydrogen	10%
Nitrogen	3%
Calcium	2%
Phosphorous	1%
Potassium	0.35%
Sulphure	0.25%
Chlorine	0.15%
Sodium	0.15%
Magnesium	0.05%
Iron	0.004%
Total Number of Bioelements	16
Number of species currently known to science	2,500,000
Insects	53.1%
Vascular plants	17.6%
Animals other than insects	19.9%
Fungi, algae, protozoa etc	9.4%
Estimated number of species on earth	5-30 million



# PRACTICE EXERCISE



1. Which character differentiates living things from non-living organisms?
  - (a) They live in the same ecosystem.
  - (b) They are acted upon by the same environment
  - (c) They are highly organized and complex, made of one or more cells, and contain genetic material.
  - (d) Both a and b.
2. The study of fossils is called:
  - (a) Environmental Biology.
  - (b) Historical biology
  - (c) Palaeontology
  - (d) Social biology.
3. The experiments on DNA molecules in chromosomes, for knowing the basis of inherited diseases are conducted by:
  - (a) Molecular biologists
  - (b) Microbiologists
  - (c) Freshwater biologists
  - (d) Social biologist.
4. Synthetic insulin from pork was formed by which technique:
  - (a) Parasitology
  - (b) Social biological techniques
  - (c) Biotechnology
  - (d) Both a and c
5. The branch of biology which deals with the study of social behavior and communal life of human beings living in any environment is called:
  - (a) Environmental biology
  - (b) Social biology
  - (c) Human biology
  - (d) Both band c
6. Out of 92 naturally occurring chemical elements, how many are considered as bio-elements:
  - (a) 06
  - (b) 16
  - (c) 26
  - (d) 15
7. Oxygen accounts for \_\_\_\_\_% of totals human body mass:
  - (a) 65%
  - (b) 18%
  - (c) 10%
  - (d) 03%
8. The atoms of different elements combine with each other through ionic or covalent bonding to produce compounds, this stable form is called:
  - (a) An organ
  - (b) A molecule
  - (c) Tissue
  - (d) Both a and c.
9. Which one is a micromolecule?
  - (a) Polysaccharide
  - (b) Protein
  - (c) Hemoglobin
  - (d) ATP
10. A structure formed by groups of similar cells, organized into loose sheets or bundles performing similar functions is called as:
  - (a) An organ
  - (b) An organism
  - (c) A Tissue
  - (d) A Cell





11. In animals coordination is achieved by means of  
(a) Respiratory system. (b) Nervous system  
(c) Endocrine system (d) Both b and c.
12. Group of living organisms of the same species living in the same place at the same time is called  
(a) Community (b) Population  
(c) Ecosystem (d) Biome
13. Different species of plants and animals living in the same habitat is called:  
(a) Population (b) Community  
(c) Biome (d) Habitat
14. A large regional community primarily determined by climate is called:  
(a) Population (b) Community  
(c) Biome (d) Habitat
15. The concept that various organisms dominated this planet during various geological time period, and thus placing organisms in a time sequence, came from the studies by  
(a) Environmental biologist (b) Paleontologist  
(c) Marine biologist (d) Social biologist
16. It is possible to date the rocks by comparing the amount of specific radioactive isotopes they contain. Which of the statement is correct in this respect:  
(a) Older sediment layers have equal amount of these radioactive isotopes as that of the young ones.  
(b) Older sediment layers have less amount of these radioactive isotopes as that of the young ones.  
(c) Older sediment layers have greater amount of these radioactive isotopes as compared to the young ones.  
(d) Older sediment layers did not have these radioactive isotopes
17. An unbroken series of species arranged in ancestors to descendent sequence with each later species having evolved from one that immediately preceded it is called:  
(a) Biome (b) Phyletic lineage  
(c) Community (d) Population
18. Biological sciences have a set methodology and it is based on  
(a) Experimental inquiry. (b) Esthetic preference  
(c) Philosophical ideas (d) Imaginations
19. A series of hypothesis supported by the results of many tests is called  
(a) Scientific law (b) Theory  
(c) Data (d) Deduction
20. Which one is not correct for a productive theory?  
(a) It is predictive  
(b) It has explanatory power  
(c) It discourages suggestion of different hypotheses.  
(d) None of these



21. Conclusion of Mendel's work latter became a  
(a) Scientific hypothesis (b) Theory  
(c) Scientific law (d) Productive theory.
22. Breeders have developed new and better varieties of food items, by using which technique:  
(a) Pasteurization (b) Hydroponic culture technique  
(c) Genetic engineering (d) Biological control techniques
23. Production of genetically identical copies of organisms/ cells by asexual reproduction is called  
(a) Mitosis (b) Replication  
(c) Cloning (d) Biological control
24. Astronauts may use which technique to grow fruits and vegetables  
(a) Tissue culture techniques (b) Cloning  
(c) Pasteurisation (d) Hydroponic culture technique
25. Which statement is incorrect for pasteurization?  
(a) It is used to preserve yogurt and milk  
(b) It was developed by Louis Pasteur.  
(c) It involves heating the substance at high temperature for just few sec.  
(d) It can be used to preserve vegetables & meat.
26. What is the mode of transmission of Hepatitis virus?  
(a) Aerosol (b) Parental (via blood)  
(c) Skin penetration (d) Unknown
27. Which disease can be controlled by vaccination?  
(a) Measles (b) Cancer  
(c) Diabetes (d) Heart attack
28. Vaccine was first developed by  
(a) Louis Pasture. (b) Edward Jenner  
(c) Jaber Ibn Hayan (d) Aristotle
29. Which disease has been totally eradicated from the world because of effective vaccination?  
(a) Measles (b) Polio  
(c) Small pox (d) Hepatitis
30. Which of the following statement is incorrect about antibiotics?  
(a) They are used against microorganisms  
(b) They are always effective against bacteria  
(c) They are used in diseases like tuberculosis and pneumonia  
(d) They are derived from bacteria only.
31. Which treatment is instituted in a cancerous patient:  
(a) Antibiotic therapy. (b) Radiotherapy  
(c) Gene therapy (d) None of these



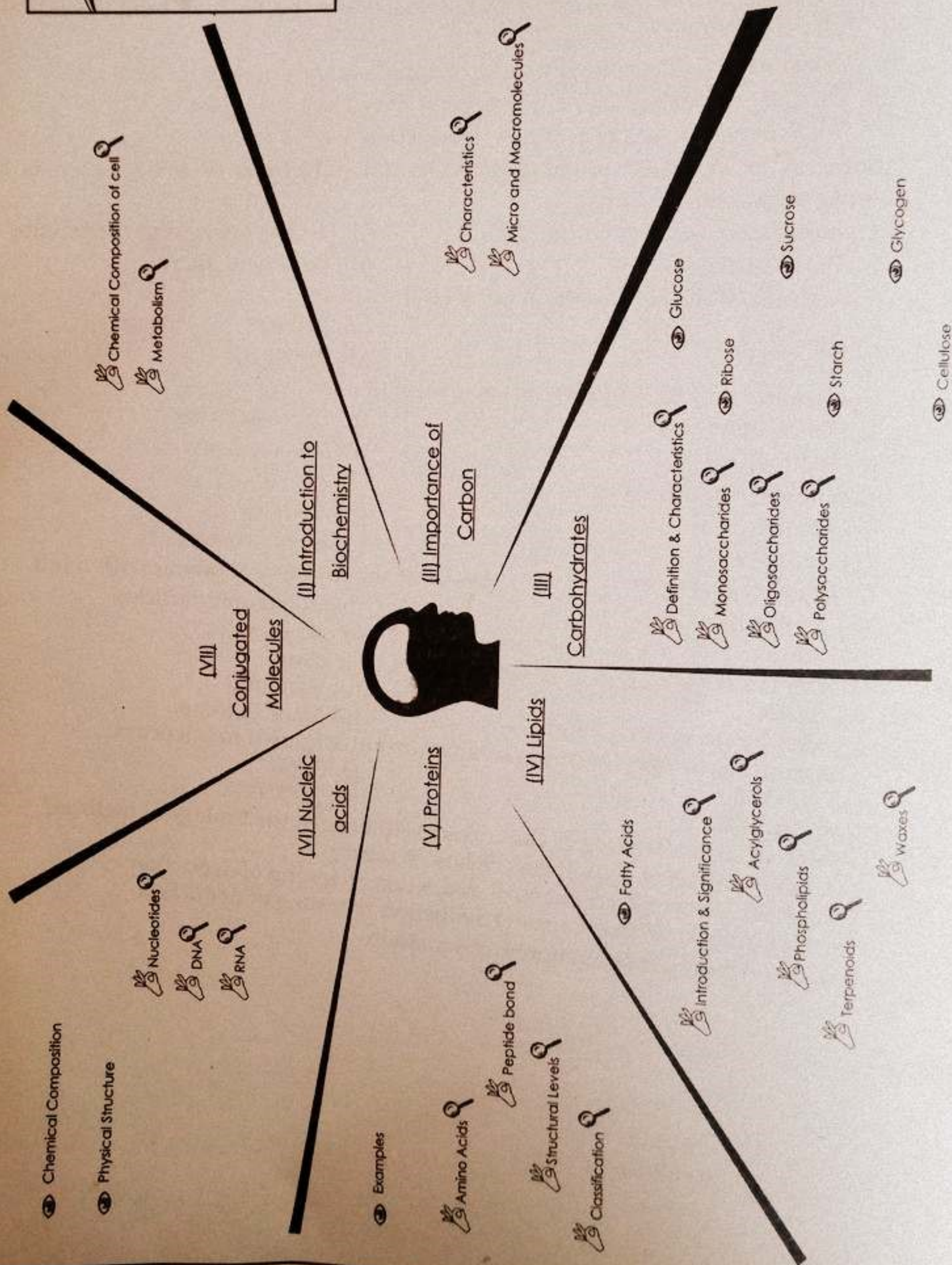


32. Which statement is incorrect for cloning?
- The nucleus of a fertilized egg is replaced by the nucleus from the cell of a fully developed individual.
  - Division of a single egg into one or more separate embryos.
  - The individual is the mirror image of the parent organism
  - It involve methods of sexual reproduction
33. Removal or degradation of environmental pollutants or toxic materials by living organisms is called
- Integrated disease management
  - Hydroponic culture technique
  - Pasteurization
  - Bioremediation.
34. Which one of the following is not a viral disease?
- Cowpox
  - Mumps
  - Tetanus
  - Small pox
35. In human body 99% of total mass is formed of
- 16 bioelements
  - 12 bioelements
  - 10 bioelements
  - 6 bioelements
36. Biological organization is
- simple
  - advance
  - complex
  - highly complex
37. The arrangement of \_\_\_\_\_ speaks of the division of labour within cell
- Molecule
  - Subatomic particles
  - Atoms
  - Organelles
38. Communities are \_\_\_\_\_ collection of organisms
- Static
  - Dynamic
  - May be static or dynamic
  - None of these
39. The number of species of organisms currently known to science is
- 3500,000
  - 3,500
  - 2,500,000
  - 2,500,0000
40. Which of the following is the correct sequence in the biological method?
- Observation → hypothesis → law → theory
  - Observation → hypothesis → deduction → testing of deduction
  - Hypothesis → observation → deduction → testing of deduction
  - law → theory → deduction → observation



# Chapter 2

## BIOLOGICAL MOLECULES







### INTRODUCTION TO BIOCHEMISTRY

- **Biochemistry** is the branch of biology, which deals with the study of chemical compounds/ components and the chemical processes in the living organisms.
- Chemical compounds are of two types:
  - Organic e.g. carbohydrates, proteins, lipids.
  - Inorganic e.g. water,  $\text{CO}_2$ , acids, bases & salts.

S.No.	Chemical Components	% Total Cell Weight	
		Bacterial Cell	Mammalian Cell
1.	Water	70	70
2.	Proteins	15	18
3.	Carbohydrates	3	4
4.	Lipids	2	3
5.	DNA	1	0.25
6.	RNA	6	1.1
7.	Other organic molecules (enzymes, hormones, metabolites)	2	2
8.	Inorganic ions ( $\text{Na}^+$ , $\text{K}^+$ , $\text{Mg}^{++}$ , $\text{Cl}^-$ , $\text{SO}_4^{--}$ etc)	1	1

- All the chemical reaction taking place within a cell are collectively called **metabolism**.

#### Metabolism

##### Anabolism

- Reactions in which simple substances are combined to form complex one.
- Anabolic reaction **require energy**.
- Different organic compounds are interconvertible, for example interconversion of carbohydrates, proteins and lipids in a body and is an example of **coordinated catabolic and anabolic reactions**.

##### Catabolism

Reactions in which there is breakdown of complex molecules into simple ones. They commonly **release energy**.

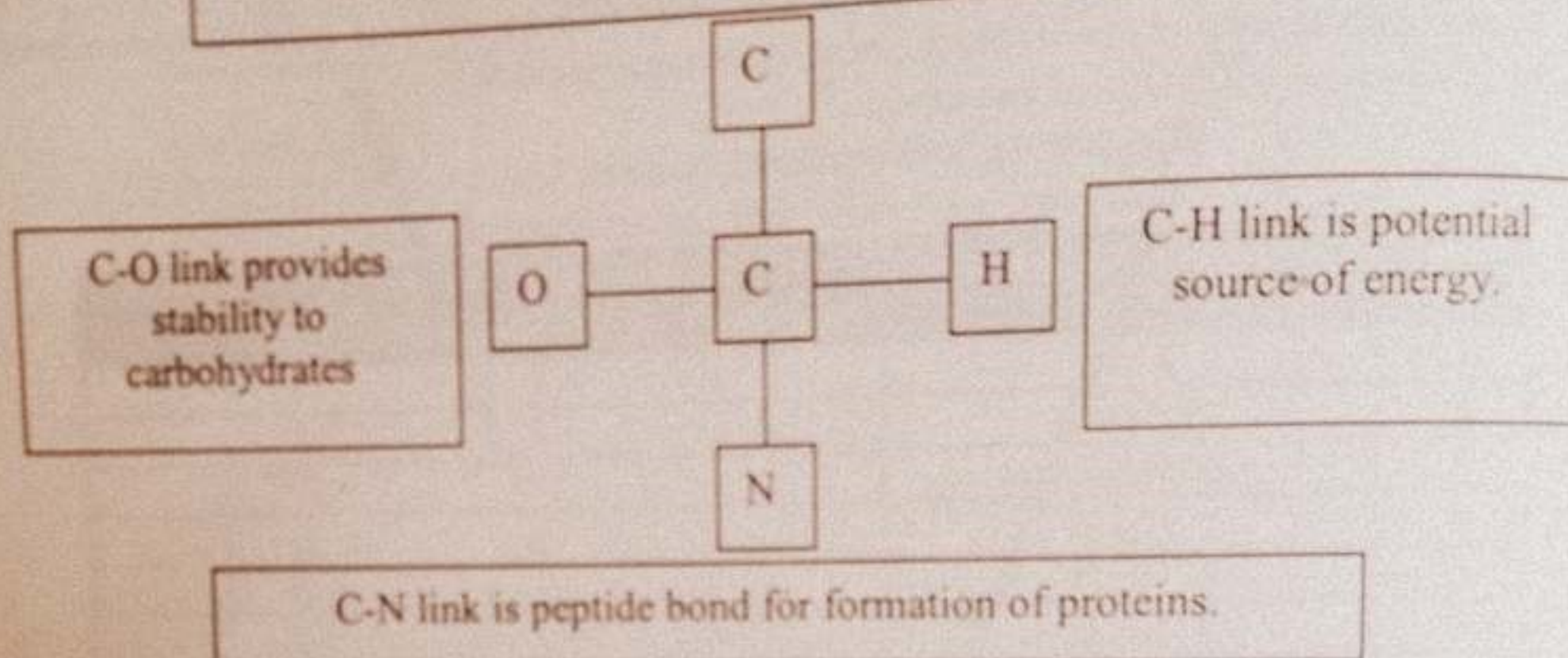
### IMPORTANCE OF CARBON

- Carbon is the **basic element** of organic compounds.
- Carbon is **tetravalent** and thus can combine with four atoms or radicals. The four bonds thus formed are arranged symmetrically in a tetrahedron.
- Carbon atom can combine mutually forming stable, branched or un branched chains or rings.
- **Covalent bond** is formed when two or more atoms complete their shells by sharing electrons.
- **Large organic molecules** e.g., cellulose, fats and proteins are generally insoluble in water hence they form the structures of cell.
- **Small organic molecules** e.g., glucose, amino acids, fatty acids etc serve either as a source of energy or a subunit to form macromolecules.
- **ATP** is such an unstable small molecule that it is immediately broken down to release energy in cellular respiration.



## Chapter 2

C-C Bond forms skeleton of organic molecules.

IMPORTANCE OF WATER

- Water is the *most abundant compound* in all organisms.
- Chemical reactions take place in the presence of water.
- It also takes part in many biochemical reactions as *hydrolysis* of macromolecules.
- It is also used as a *raw material* in reactions like photosynthesis.
- Water varies from 65 to 89% in different organisms.
- Human tissues contain about 20% water in bone cells and 85% in brain.

Solvent Properties

- Water is an *excellent solvent* for polar substances due to its dipole nature.
- Almost all the reactions in cells occur in aqueous media even enzymes work in aqueous environment. Ions and molecules *move randomly* and are in a more favorable state to react with other molecules and ions when in solution.
- Molecules which are *insoluble* in water, for example non polar organic molecules like fats help to maintain membranes which make compartments in the cell.

Heat Capacity

- *Specific heat capacity of water* is the number of calories required to raise the temperature of 1g of water from 15 to 16°C is called specific heat capacity. It is 1 calorie for water.
- Water has great ability to absorb the heat, since most of the heat is used to break hydrogen bonds. Thus it act as an efficient *temperature stabilizer*.

Heat Of Vaporization

- Amount of heat absorbed when 1g of water changes from liquid to gaseous state is called *heat of vaporization*.
- Specific heat of vaporization of *water* is 574 Kcal/kg.
- Evaporation of only 2ml out of 1 liter of water lowers the temperature of remaining 998ml by 1°C.
- The advantages of high heat of vaporization of water is that it provides cooling effect to plants and animals.

Ionization Of Water

- $\text{H}_2\text{O} \rightleftharpoons \text{H}^+ + \text{OH}^-$  It is a reversible reaction.





## Chapter 2

## Biological Molecules

- At 25°C, the concentration of each  $H^+$  and  $OH^-$  ions in pure water is about  $10^{-7}$  moles/lit.
- $H^+$  and  $OH^-$  ions take part in many reactions that occur in cell.

## Protection

- As a lubricant against friction, e.g., *tears* protect the surface of eye from the rubbing of eyelids.
- A fluid cushion around organs that protect them from trauma.



1. %age of carbohydrate in a bacterial cell out of total cell weight is \_\_\_\_\_.
2. \_\_\_\_\_ link is peptide bond for formation of proteins.
3. Most abundant inorganic compound of a cell is \_\_\_\_\_.
4. Human bone cells contain \_\_\_\_\_ % water.
5. Heat of vaporization of water is \_\_\_\_\_.
6. Out of polar and non-polar molecules \_\_\_\_\_ is insoluble in water.

CARBOHYDRATES

- Carbohydrates literally mean "*hydrated carbons*", also called "Saccharides" (derived from Greek word Sakcharon meaning sugar).
- They are composed of C, H, and O.
- **Chemically** they are **defined** as "polyhydroxy aldehyde or ketones or complex substances which on hydrolysis yield polyhydroxy aldehyde or ketone subunits."
- Their **general formula** is  $C_x (H_2O)_y$ .
- Simple carbohydrates are the main **source of energy** in cell.
- Some are the main **constituents of cell walls** in plants and microorganisms.
- **Examples** are cellulose of wood, cotton and paper, starches present in cereals, root tubers, cane sugar and milk sugar.
- Their **main sources** are green plants, which produce them by photosynthesis. Even all the other compounds of plants are synthesized from carbohydrates.
- Carbohydrates combine with proteins and lipids to form *glycoprotein & glycolipids* respectively.

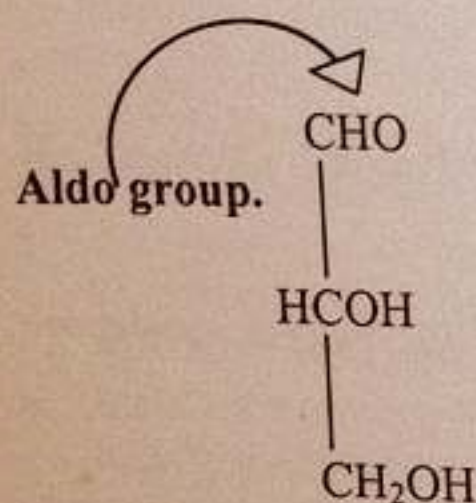
Answers: (1) 3% (2) C-N (3) Water (4) 20% (5) 574 Kcal/Kg (6) Non-polar



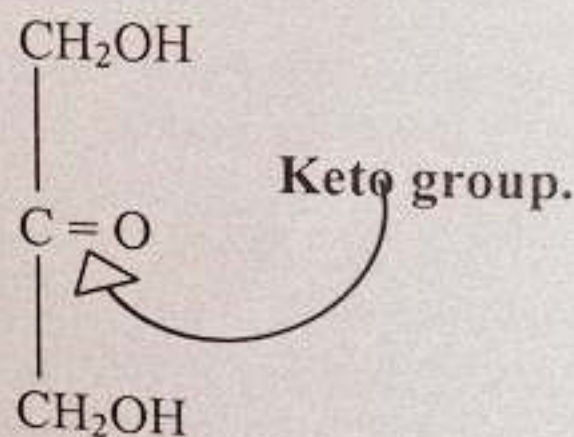
## Major Groups Of Carbohydrates

Feature	Monosaccharides	Oligosaccharides	Polysaccharides
Common Name	Simple sugars	Complex sugars	Most complex sugars
Taste	Sweet	Less sweet	Tasteless
Solubility in water	Easily soluble	Less soluble	Insoluble and high molecular weight
Hydrolysis	Can't be hydrolyzed	Can be hydrolyzed	Can be hydrolyzed
General Formula	$(CH_2O)_n$	$(CH_2)_nO_{n-1}$	-
Classification	On base of number of carbon atoms e.g. trioses, tetroses, pentoses etc.	On base of monosaccharides released during hydrolysis e.g. disaccharides, trisaccharides etc.	On base of structural complexity & relation e.g. starch, glycogen, cellulose etc.

## Monosaccharides



Glyceraldehyde



Dihydroxyacetone

In nature monosaccharide with 3 – 7 C atoms are found.

ATOMS	TYPE	FORMULA	EXAMPLES
3 C	Trioses	$C_3H_6O_3$	Glyceraldehydes, Dihydroxyacetone
4 C	Tetroses	$C_4H_8O_4$	
5 C	Pentoses	$C_5H_{10}O_5$	Rare, Found in some bacteria
6 C	Hexoses	$C_6H_{12}O_6$	Ribose found in RNA
7 C	Heptose	$C_7H_{14}O_7$	Glucose, Fructose Heptolose

- Most monosaccharide form a **ring structure** in solution.
- Ribose forms a five cornered ring called **ribofuranose** in solution.
- Glucose forms six cornered ring called **glucopyranose** in solution.

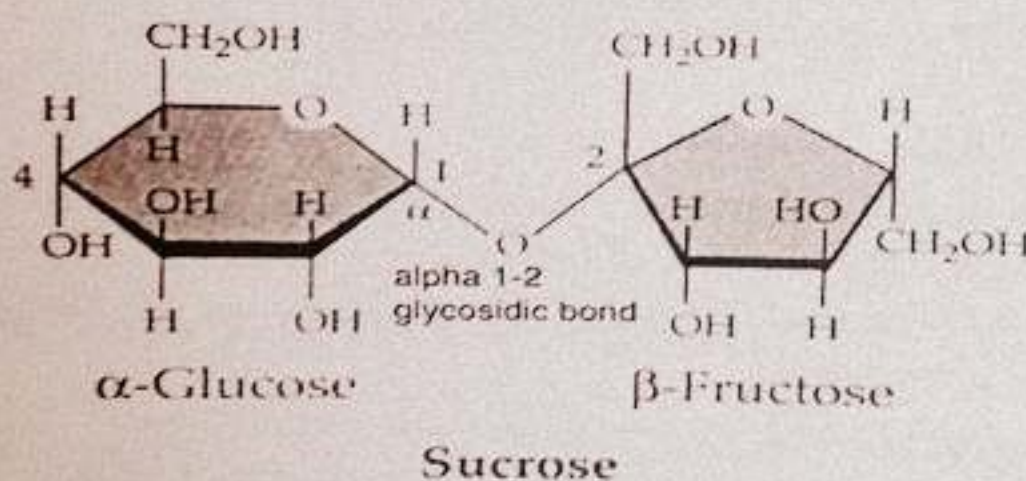
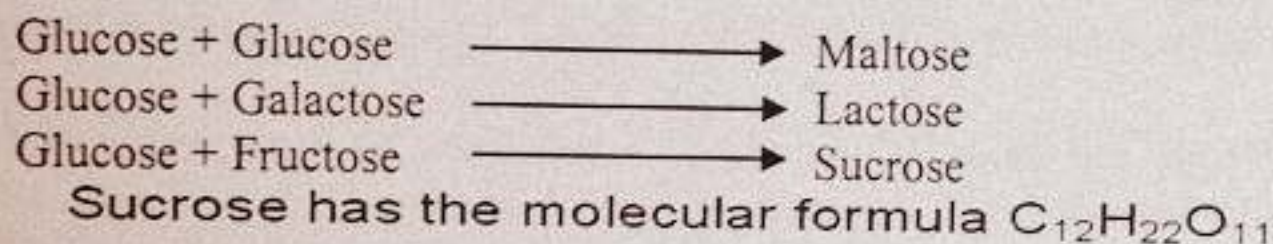


**Glucose**

- Naturally produced in green plants via photosynthesis which consumes energy provided by sunlight.
- Synthesis of *10g of glucose* requires *717.6 Kcal* of solar energy, which in turn is stored in glucose molecule and becomes available in all organisms when it is oxidized in the body.
- Our *blood* contains *0.08%* glucose.
- Starches, cellulose, and glycogen yield glucose on complete hydrolysis.

**Oligosaccharides**

- Those oligosaccharides which yield two monosaccharide on hydrolysis are called *disaccharides* and those yielding three are called *trisaccharides*.
- The covalent bond between two monosaccharides is called *glycosidic bond*.
- *Maltose, sucrose, and lactose* all are disaccharides.
- *Sucrose* (cane sugar) on hydrolysis releases glucose and fructose (both monosaccharide and reducing sugars).

**Polysaccharides**

- They are formed by many monosaccharide units linked by glycosidic bonds.
- Starches, glycogen, cellulose, dextrin, agar, pectin and chitin all are polysaccharides.

**Classes Of Polysaccharides**

Feature	Starch	Glycogen	Cellulose
Organism	Plants	Animals	Plants
Location	Fruits, grains, seeds, tubers.	Liver & skeletal muscle.	Cell wall
Main function	Main source of carbohydrates for animals.	Chief storage form in animals.	Main constituent of cell wall of plants.
Result of hydrolysis	Glucose molecules	Glucose molecules	Glucose molecules
Solubility	Soluble in hot water (amylopectin are not)	Insoluble	Highly insoluble
Iodine test	Blue colour	Red colour	No colour change



**Starches**  
There are two types of starches i.e. amylase & amylopectin.

FEATURE	AMYLOSE	AMYLOPECTIN
Structure	Unbranched chain	Branched chain
Solubility	Soluble in hot water	Insoluble in hot or cold water
Glucose linkage	1,4 glycosidic linkage	1,4 & 1,6 glycosidic linkages

### Cellulose

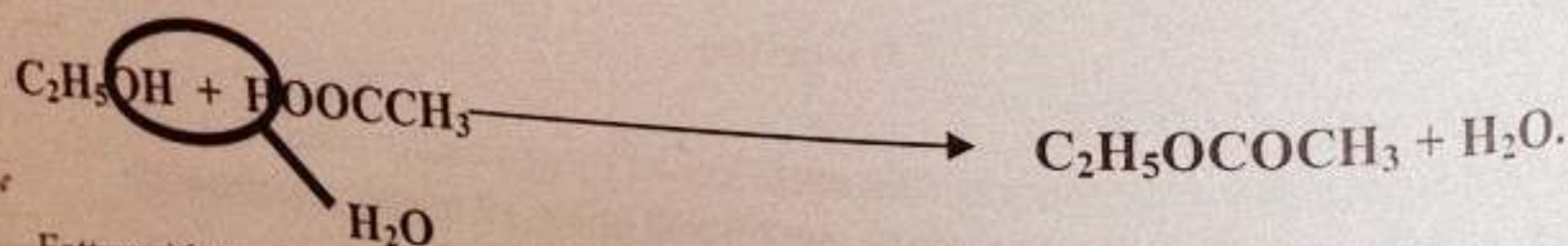
- Cotton is a pure form of cellulose.
- It is not digested in human digestive tracts.

## LIPIDS

- Lipids are *hydrophobic compounds*.
- They are *insoluble in water* but *soluble in organic solvents* like ether, alcohol, chloroform and benzenes.
- Their hydrophobic nature makes them best suited to be a *structural component of cell membranes*.
- Lipids store *double the amount of energy* as compared to same amount of carbohydrates because of high proportion of C-H bonds and very low oxygen.
- May act as *insulating layer* e.g., waxes in exoskeleton of insects, and cutin which is an additional layer on the cuticle of epidermis of some plant organs.

### Acylglycerol

- They are composed of *glycerol and fatty acids* e.g., triacylglycerides or neutral lipids.
- Chemically they are defined as *esters* of fatty acids and alcohol.
- *Ester* is a compound produced as a result of a chemical reaction of an alcohol with an acid and a water molecule is released.



- Fatty acids having no double bond are called *saturated fatty acids*.
- Fatty acids having double bond are called *unsaturated fatty acids*.
- *In animals*, fatty acids are straight chain while *in plants* they are ringed or branched.
- *Solubility* of fatty acids in organic solvents and their *melting points* increases with increase in number of C atom in their chains.
- Phospholipids, an example of lipids, are the basic structural component of cell membrane.
- Lipids are considered better source of energy than carbohydrates and proteins.
- Fats containing unsaturated fatty acids are usually liquid at room temperature and are said to be *oils*.
- *Fats* containing saturated fatty acids are usually solid at room temperature.
- *Animal fats* are solid at room temperature.





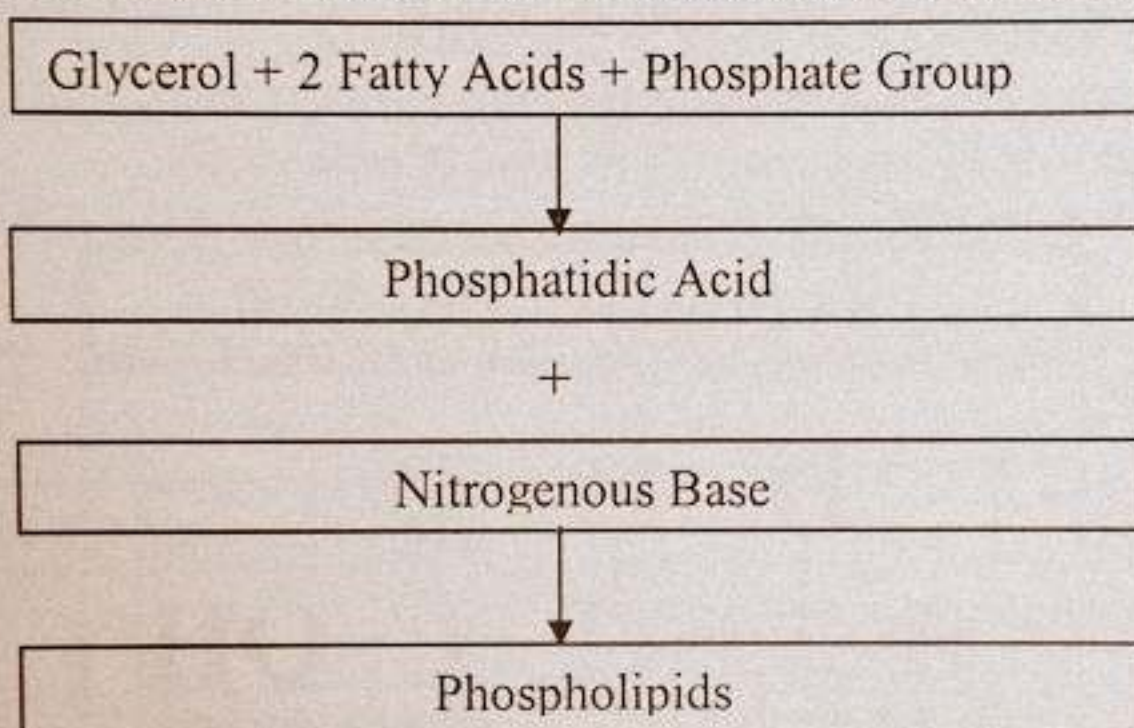
- Most of the *plant fats* are liquid.
- Both the fats and oils are lighter than water having *specific gravity* of about 0.8.

### Waxes

- They act as *protective coating* on the fruits and leaves and thus protect them from water loss and abrasive damage.
- They also provide *water barrier* for insects, birds and animals such as sheep.

### Phospholipids

- They are the derivatives of *phosphatidic acid*.
- They are frequently associated with *biological membranes*.
- *Phosphatidylcholine* is one of its commonest examples also called *lecithin*.



### Terpenoids

They are made of simple repeating units called *isoprenoid units*.



1. The main source of carbohydrates on land are \_\_\_\_\_.
2. \_\_\_\_\_ carbohydrates cannot be hydrolyzed.
3. Out of ribose & fructose, which one is pentose \_\_\_\_\_?
4. \_\_\_\_\_ is pure form of cellulose.
5. Specific gravity of fats & oils is \_\_\_\_\_.
6. Phospholipids are derivatives of \_\_\_\_\_.
7. All lipids are non-polymers except \_\_\_\_\_.

Answers: (1) Plants (2) Monosaccharides (3) Ribose (4) Cotton (5) 0.8 (6) Phosphatidic acid (7) Terpenoids



**PROTEINS**

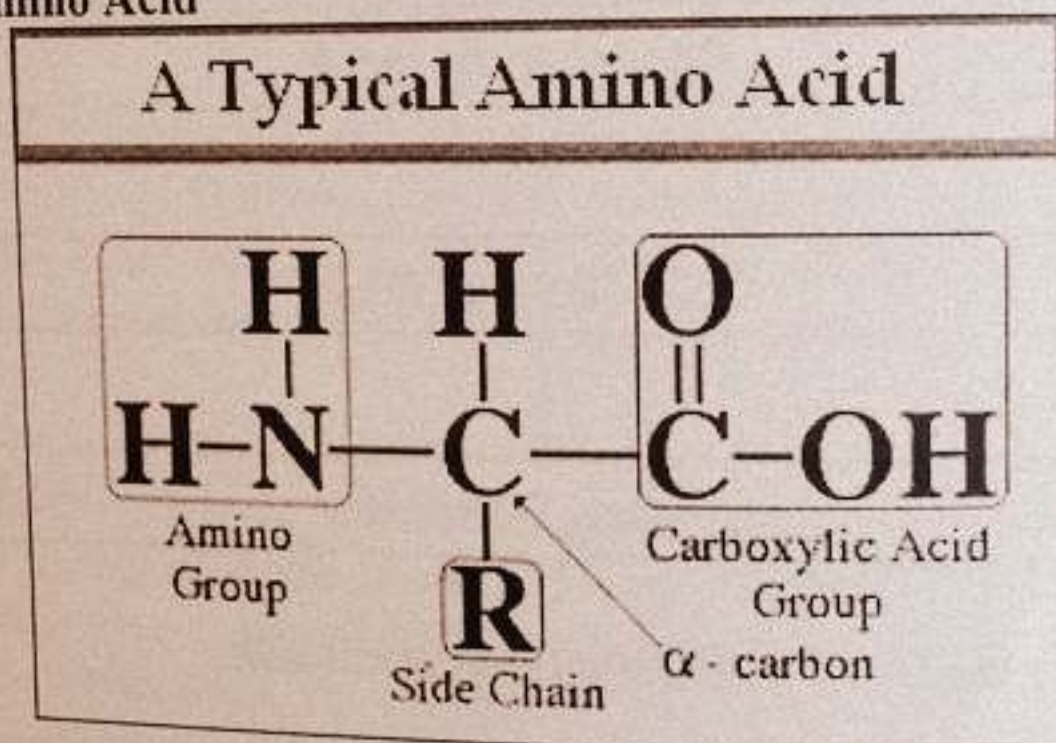
- They are the **most abundant organic compounds** found in cells, comprising over 50% of their total dry weight.
- Proteins are polymers of amino acids, compounds containing **C, N, O, and H**.

**MAJOR FUNCTIONS**

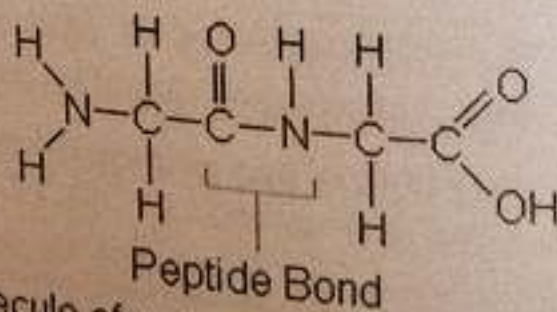
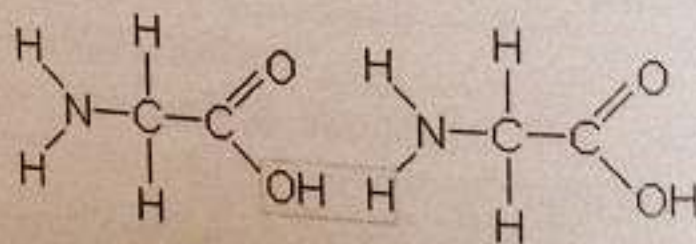
EXAMPLE	
Enzymes	Catalyse chemical reactions and control whole metabolism of cell
Hormones	Regulate metabolic process and control body activities.
Hemoglobin	Carrier proteins that transport $O_2$ , $CO_2$ , lipids etc.
Antibodies	Defend the body against pathogens.
Clotting proteins	Prevent loss of blood after injury.
Mitotic apparatus	Helps in movement of chromosomes during cell division

**Amino Acids**

- About **170** amino acids have been found in cells and tissues.
- Out of 170 types only **25** are constituents of proteins.
- Most of the proteins are however made of **20** types of amino acids.

**Basic Structure Of Amino Acid**

- Amino acids link together to form a polypeptide molecule.



A molecule of water is removed from two glycine amino acids to form a peptide bond.

- In this figure -OH of carboxyl group of one amino acid combines with H of amino group of another amino acid releasing water and forming C-N link called **peptide bond**.





- Two amino acids combine together via a peptide bond to form a dipeptide, e.g., Alanine and Glycine form *glycylalanine*. Similarly tri, tetra and pentapeptides can be formed.

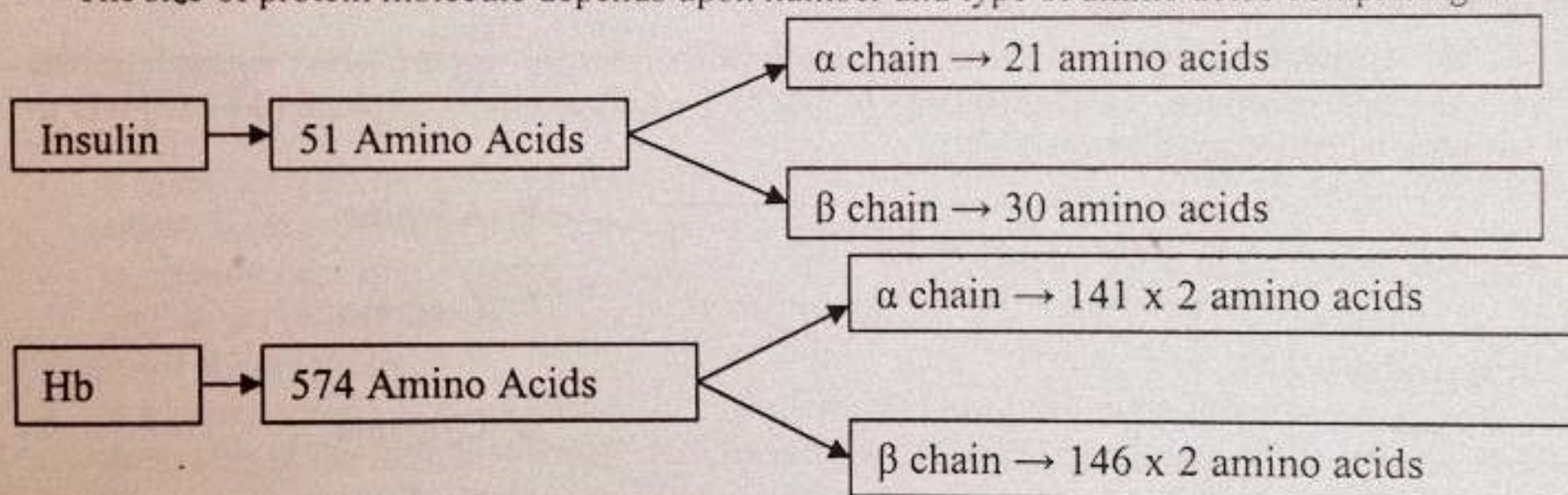
### Structure Of Proteins

There are four levels of organization of protein molecules.

FEATURE	PRIMARY	SECONDARY	TERTIARY	QUATERNARY
Information	Number & sequence of amino acids	Coiling	Bending & folding	Aggregation
Bonds	Disulphide	Hydrogen	Ionic, Hydrogen, Disulphide	Hydrophobic, Hydrogen, Ionic
Example	Insulin, Hb	Alpha helix	Single chain of Hb	Hb molecule

### Primary Structure

- F. Sanger** was the first scientist who determined the sequence of amino acids in a protein molecule.
- The **sequence of amino acids** in a protein molecule is determined by the order of nucleotides in the DNA.
- The **size** of protein molecule depends upon number and type of amino acids comprising it.



- A **change** in even a single amino acid, results in the failure of that protein, which may even lead to death, e.g., replacement of Glutamic acid by Valine in Hb molecule results in formation of HbS, which fails to carry Oxygen, the characteristic of sickle cell anemia ultimately leading to death.

### Secondary Structure

- $\alpha$ -helix and  $\beta$ -pleated sheets are its **examples**.
- $\alpha$ -helix** is a very uniform geometric structure with 3.6 amino acids in each turn of the helix.
- $\beta$ -pleated sheet** is formed by the fold backs of the polypeptide.

### Tertiary Structure

In aqueous environment, the most stable tertiary structure is that in which hydrophobic amino acids are buried inside while the hydrophilic amino acids are on the surface of molecule.

### Quaternary Structure

Polypeptide tertiary chains are aggregated and held together by hydrophobic interactions.





## Chapter 2

## Biological Molecules

## Classification Of Proteins

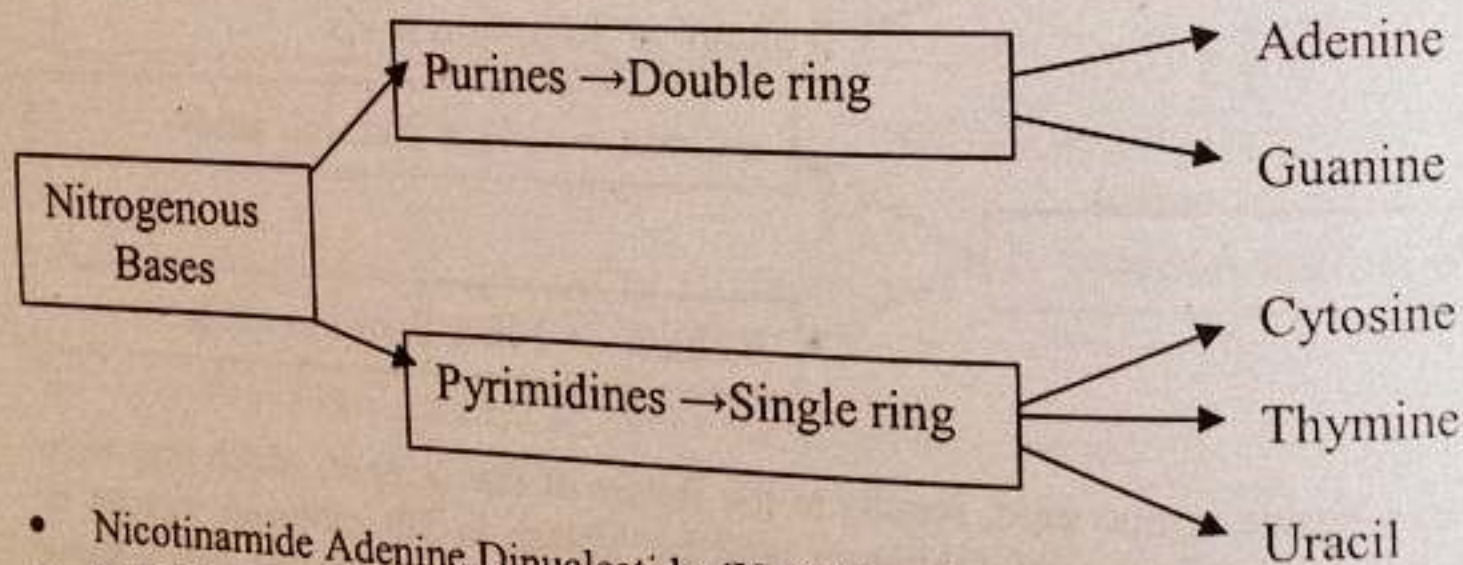
FEATURE	FIBROUS PROTEIN	GLOBULAR PROTEINS
Shape	Fibrils	Spherical or ellipsoidal
Structural organization	Secondary	Tertiary
Solubility in aqueous media	Insoluble	Soluble
Crystal Nature	Non-crystalline	Crystalline
Elasticity	Elastic	Inelastic
Role	Structural	Functional
Stability	Stable	Unstable
Examples	Silk fibers, actin, myosin, fibrin, keratin	Enzymes, antibodies, hormones, hemoglobin.

## NUCLEIC ACIDS (DNA AND RNA)

- Nucleic acid were first isolated by **F. Mischer** from nuclei of pus cells.
- They are called nucleic acid, since they were first isolated from nuclei and are acidic in nature.
- ATP** is an imported nucleotide used as an energy currency by the cell.

## Deoxyribonucleic Acid (DNA)

- DNA is made up of four kinds of **nucleotides** namely d-adenosine monophosphate (d-AMP), d-guanosine monophosphate (d-GMP) d-cytidine monophosphate (d-CMP) and d-thymidine monophosphate (d-TMP).



- Nicotinamide Adenine Dinucleotide (**NA(d)**) is a dinucleotide and an important co-enzyme molecule.
- In 1951, **Erwin Chargoff** provided data about the ratios of different bases present in a DNA molecule.
- In each turn of DNA, there are about 10 base pairs of about 36 Angstrom unit.
- Haemophilus Influenza** is the first microbe to have the genome completely sequenced.

## Ratios Between Different Nitrogenous Bases

Source of DNA	Adenine	Guanine	Thymine	Cytosine
Man	30.9	19.9	29.4	19.8
Sheep	29.3	21.4	28.3	21.0
Wheat	27.3	22.7	27.1	22.8
Yeast	31.3	18.7	32.9	17.1



Amount Of

## Type of

Red Blood

Liver Cells

Kidney Cells

Sperm Cells

Ribonucleic

RNA is a polymer

Types Of RNA

There are three

## FEATURE

Function

Length

Percentage

Messenger RNA

- It takes time

amino acids

- It consists

well as the

Transfer RNA

- It transfers

according to

- There is

molecular

Ribosomal RNA

- It acts as

- It is strong

## FEATURE

Nucleotide

Pentose Sugar

Nitrogenous

Physical

Location

Amount

Role





## Chapter 2

## Biological Molecules

### Amount Of DNA In Somatic And Germ Cells

<u>Type of cell</u>	<u>Amount of DNA/nucleus in picogram in Chicken</u>	<u>Amount of DNA/nucleus in picogram in Carp</u>
Red Blood Cells	2.3	3.3
Liver Cells	2.4	3.3
Kidney Cells	2.4	3.3
Sperm Cells	1.3	1.6

### Ribonucleic Acid (RNA)

RNA is a polymer of ribonucleotide.

### Types Of RNA

There are three main types of RNAs.

<b>FEATURE</b>	<b>mRNA</b>	<b>tRNA</b>	<b>rRNA</b>
Function	Takes message from DNA	Transfers amino acids	Formation of ribosomes
Length	Single strand of variable length	Length of 75-90 nucleotides	Constant length
Percentage	3-4%	10-20%	80%

### Messenger RNA (mRNA)

- It takes the genetic message from DNA in the nucleus to ribosome in the cytoplasm, where amino acids are arranged to form a specific protein molecule.
- It consists of a single strand of variable length, which depends upon the size of the gene as well as the protein for which it is taking the message.

### Transfer RNA (tRNA)

- It transfer amino acid molecules to ribosome where they are arranged in a specific manner according to the information delivered by mRNA to form a specific protein molecule.
- There is one specific tRNA for each amino acid. So there are at least 20 kinds of tRNA molecules.

### Ribosomal RNA (rRNA)

- It act as a machinery for the synthesis of proteins.
- It is strongly associated with the ribosomal proteins where 40 – 50 % of it is present.

<b>FEATURE</b>	<b>DNA</b>	<b>RNA</b>
Nucleotides	Deoxyribonucleotides	Ribonucleotides
Pentose Sugar	Deoxyribose	Ribose
Nitrogenous Bases	A, G, C, T	A, G, C, U
Physical Structure	Double strands	Single strand
Location	Nuclei, and in much lesser amount in mitochondria and chloroplasts.	Nucleolus, ribosomes, cytosol and in smaller amount in other parts of the cell.
Amount	Constant in each cell of species	Variable from cell to cell
Role	Heredity	Protein synthesis



CONJUGATED MOLECULES

Two different molecules, belonging to different categories, usually combine together to form conjugated molecules.

COMPONENTS	MOLECULE	ROLE
Carbohydrates + Proteins	Glycoproteins	Cellular secretions, Integral part of biological membranes.
Carbohydrates + Lipids	Glycolipids	Integral component of biological membranes
Nucleic acid + Histones	Nucleohistones	Chromosome + Regulation of gene expression.



- \_\_\_\_\_ are most abundant organic compounds.
- About \_\_\_\_\_ amino acids have been discovered so far.
- During peptide bond formation OH is released from \_\_\_\_\_ group.
- In alpha helix, each turn contains \_\_\_\_\_ amino acids.
- Out of thymine & uracil, \_\_\_\_\_ is not present in DNA.
- \_\_\_\_\_ is the first microbe to have the genome completely sequenced.
- %age of mRNA out of all RNAs is \_\_\_\_\_.
- \_\_\_\_\_ conjugated molecule forms chromosome.

Answers: (1) Proteins (2) 170 (3) COOH (4) 3.6 (5) Uracil (6) *Hemophilus influenzae* (7) 3-4% (8) Nucleohistone



## ----- VALUES -----

Property	Value
Range of water in different organisms	65-89%
Amount of water in bone cells	20%
Amount of water in brain cells	85%
Specific heat capacity of water	1.0
Heat of vaporization of water	574 Kcal/Kg
Concentration of $H^+$ & $OH^-$ in pure water	$10^{-7}$ mole/litre
Number of carbon atoms in natural monosaccharides	3-7
Glucose in human blood	0.08%
Amount of solar energy required to synthesize 10g glucose	717.6 Kcal
Number of carbon atoms in fatty acids	4-30
Melting point of palmitic acid	63.1°C
Melting point of butyric acid	-8°C
Specific gravity of fats & oils	0.8
Number of carbon atoms in alkanes of waxes	25-35
%age of proteins out of total dry weight of body	50%
Total amino acids	170
Amino acids as constituents of proteins	25
Amino acids in most of the proteins	20
Amino acids in Insulin	51 (21 + 30)
Amino acids in Hemoglobin	574 (141 in alpha + 146 in beta)
Proteins in human body	10,000
Number of amino acids in each turn of alpha helix	3.6
Position of nitrogenous base on pentose sugar	1
Position of phosphate on pentose sugar	3,5
Number of base pairs in each turn of DNA	10
Diameter of a turn of DNA	34 Angstrom
Number of bases in paired strand of DNA in E.Coli	5 million
Number of base pairs in genome of E.Coli	4,639,221 for 4288 proteins





## PRACTICE EXERCISE

 60 mins  
Time Yourself

- The branch of biology, which deals with the study of chemical compounds and the chemical processes in the living organisms is called:
  - Chemistry
  - Biochemistry
  - Molecular biology
  - Both a and b.
- Which one is an organic compound?
  - CO<sub>2</sub>
  - Water
  - Lipids
  - HCl.
- Which chemical component has the same % in bacterial as well as the mammalian cell?
  - Water
  - Carbohydrate
  - Proteins
  - Lipids
- Which chemical component has the greatest contribution in the total mammalian cell weight?
  - Proteins
  - Carbohydrate
  - Lipids
  - Water
- Reactions in which simple substances are combined to form complex substances are called:
  - Metabolic reactions
  - Catabolic reactions
  - Anabolic reactions
  - None of these
- Which one is the basic element of organic compounds?
  - Oxygen
  - Hydrogen
  - Sulphur
  - Carbon
- The bond formed when two or more atoms complete their electron shells by sharing electrons is called:
  - Ionic bond
  - Hydrogen Bond
  - Covalent bond.
  - Electrovalent bond
- Carbon atom is
  - Monovalent.
  - Divalent
  - Trivalent
  - Tetravalent.
- Which bond provides stability to complex carbohydrate molecules?
  - C- H
  - C- O
  - C- C
  - C- N
- % of water in brain cells is
  - 20%
  - 80%
  - 85%
  - 90%
- Which statement is true about an aqueous medium:
  - Ionic as well as non ionic substance in aqueous media retains their identity.
  - Enzymes can't perform catalysis reaction in this medium.



- (c) Ions and molecules move randomly, thus are in more favorable state to react with other molecules and ions.  
 (d) It is less favorable media for chemical reactions.
12. Which of the following substance is most favorable to form structural component of biological membranes?  
 (a) Hydrophilic Carbohydrates (b) Hydrophobic fats.  
 (c) Both a and b (d) None of these
13. The number of calories required to raise the temperature of 1g of water from 15 to 16°C is called?  
 (a) Specific Heat of Vaporization (b) Specific Heat capacity.  
 (c) Caloric Heat. (d) Both A and C
14. The property of water due to which it works as a temperature stabilizer and hence protect living organisms from sudden thermal changes is:  
 (a) High specific heat of vaporization. (b) High specific heat capacity  
 (c) Its Dipole nature. (d) Its liquid state.
15. Specific heat of vaporization of water is:  
 (a) 574 Kcal/kg. (b) 674 Kcal/kg.  
 (c) 774 Kcal/kg. (d) 874 Kcal/kg.
16. A complex substance which on hydrolysis yields polyhydroxy aldehyde or ketone subunits is called:  
 (a) Lipid (b) Carbohydrate  
 (c) Protein (d) Carotein
17.  $C_n(H_2O)_n$  is a general formula of:  
 (a) Monosaccharides (b) Oligosaccharides  
 (c) Ploysaccharides (d) Carbohydrates.
18. Which of the statement is not true for compounds like glycoprotein and glycolipids?  
 (a) They are conjugated molecules of carbohydrates  
 (b) Both have role in the extra cellular matrix of animals and bacterial cell wall.  
 (c) They are components of biological membranes.  
 (d) Both are produced and secreted by endoplasmic reticulum.
19. Which one are most complex sugar:  
 (a) Monosaccharide (b) Oligosaccharides  
 (c) Polysaccharides (d) None of these
20. Which of the following carbohydrate is tasteless?  
 (a) Monosaccharide (b) Oligosaccharide  
 (c) Polysaccharide (d) None of these
21. Which of the following carbohydrate can't be hydrolysed?  
 (a) Monosaccharide (b) Oligosaccharide  
 (c) Polysaccharide (d) None of these
22. Ribose is an example of  
 (a) Trioses (b) Tetroses  
 (c) Pentose (d) Hexose





23. % of Glucose normally present in our blood is  
(a) 0.8% (b) 0.08 %  
(c) 1.8 % (d) 8%
24. Starch, cellulose, and glycogen yield \_\_\_\_\_ on complete hydrolysis.  
(a) Maltose (b) Sucrose  
(c) Fructose (d) Glucose
25. For the synthesis of 10g of glucose \_\_\_\_\_ of energy is required:  
(a) 717.6 Kcal (b) 727 Kcal  
(c) 737 Kcal (d) 747 Kcal
26. Which one is abundant in animals?  
(a) Starch (b) Glycogen  
(c) Cellulose. (d) None of these
27. Which one is soluble in hot water?  
(a) Starch (b) Glycogen  
(c) Amylose (d) Amylopectin.
28. The covalent bond between two monosaccharide subunits is called:  
(a) Phosphodiester bond (b) Peptide bond  
(c) Glycosidic Bond (d) Ionic bond
29. Which one gives blue colour with iodine?  
(a) Starch (b) Glycogen  
(c) Cellulose (d) Polysaccharide.
30. Which of the following polysaccharide is called animal starch?  
(a) Starch (b) Glycogen  
(c) Cellulose (d) None of these
31. \_\_\_\_\_ is an example of pure form of cellulose  
(a) Silk. (b) Wool  
(c) Cotton. (d) Paper.
32. Lipids are soluble in which of the following:  
(a) Water (b) Ether  
(c) All solvents (d) Not in any of the above.
33. Lipid molecules can store double amount of energy, as compared to same amount of carbohydrate because of high number of  
(a) C- C bonds (b) C-H bonds  
(c) C- N bonds (d) C- O bonds
34. A compound produced as a result of a chemical reaction of an alcohol with an acid in which water molecule is released is called:  
(a) Monosaccharide (b) Fatty acid  
(c) Neutral lipid (d) Nucleic acid
35. Fatty acids containing 18 C atoms and a single double bond is  
(a) Saturated Fatty acid (b) Unsaturated fatty acid  
(c) Oleic Acid (d) Palmitic acid



36. Which one the following fatty acid is more soluble in an organic solvent, and has higher melting point?  
(a) Acetic acid (b) Butyric acid.  
(c) Palmitic acid (d) All have same
37. Which of the following statement is incorrect for fats containing unsaturated fatty acid?  
(a) They contain double bond.  
(b) They are usually solid at room temperature  
(c) They are lighter than water.  
(d) Their specific gravity is less than 1
38. Animals obtain carbohydrates mainly from  
(a) Glucose (b) Starch  
(c) Sucrose. (d) Glycogen.
39. Peptide bond is :  
(a) C-N link (b) C- O link  
(c) N-H link (d) C-H link
40. Chemical component/s less in eukaryotic cell as compared to prokaryotic cell is/ are  
(i) lipids  
(ii) carbohydrates  
(iii) proteins  
(iv) DNA  
(a) i & ii (b) iii & iv  
(c) i, ii, iii & iv (d) iv only
41. Proteins comprise of \_\_\_\_\_% of the total dry weight of a cell.  
(a) 40 % (b) 50%  
(c) 60% (d) 70%
42. Proteins are polymers of  
(a) Fatty acids. (b) Isoprenoid units.  
(c) Amino acids. (d) Nucleotides
43. The element in basic structure of proteins which differentiate them from carbohydrates is  
(a) C (b) S  
(c) H (d) N
44. Total number of amino acids discovered so far in cells and tissues are  
(a) 20 (b) 25  
(c) 150 (d) 170
45. In Glycin, an amino acid, R group is replaced by  
(a) H (b)  $\text{CH}_3$   
(c)  $\text{COOH}$  (d)  $\text{C}=\text{O}$





46. A bond formed by linkage between -OH of carboxyl group of one amino acid and H of amino group of another amino acid which releases water is called  
 (a) Phosphodiester linkage. (b) Glycosidic bond  
 (c) Peptide bond. (d) Hydrogen bond
47. Total number of amino acids in a hemoglobin molecule are:  
 (a) 554 (b) 564  
 (c) 574 (d) 584
48. An insulin molecule consists of \_\_\_\_\_ polypeptide chains.  
 (a) 1 (b) 2  
 (c) 3 (d) 4
49. Which structure of protein gives information about number and sequence of amino acids in it?  
 (a) Primary structure. (b) Secondary structure.  
 (c) Tertiary structure. (d) Quaternary structure.
50. In an aqueous environment the most stable tertiary conformation is that in which \_\_\_\_\_ amino acids are buried inside the conformation.  
 (a) Hydrophobic (b) Hydrophilic  
 (c) Basic (d) None of these
51. Hemoglobin molecule exhibits which structural organization of proteins  
 (a) Primary structure. (b) Secondary structure.  
 (c) Tertiary structure. (d) Quaternary structure
52.  $\alpha$ -helical structure is kept by the formation of \_\_\_\_\_ bonds among amino acids molecules.  
 (a) H bonds (b) Disulphide Bond  
 (c) Ionic bond (d) Hydrophobic bonds.
53. Which of the following does not show quaternary structure?  
 (a) Haemoglobin (b) Pepsin  
 (c) Fibrin (d) Insulin
54. Which structural organization is most common in globular proteins?  
 (a) Primary (b) Secondary.  
 (c) Tertiary (d) Quaternary.
55. Actin and myosin are the basic proteins involved in contractile machinery of our body, to which type of proteins do they belong?  
 (a) Globular proteins (b) Fibrous Proteins  
 (c) Both a and b (d) None of these
56. Antibodies play important role against microorganisms and other pathogens, to which type of proteins do they belong?  
 (a) Globular proteins (b) Fibrous Proteins  
 (c) Both a and b (d) None of these
57. ATP is a an important molecule for its major function  
 (a) As an energy currency of the cell. (b) As a coenzyme.  
 (c) Both and b (d) None of these



58. Each turn of DNA contain \_\_\_\_\_ nitrogenous base pairs  
 (a) 05 (b) 10  
 (c) 20 (d) 25
59. The first organism of whose genome was completely discovered was  
 (a) Human beings (b) Influenza Virus.  
 (c) *Hemophilus Influenza*. (d) None of these
60. Which of the following statement is incorrect about RNA?  
 (a) The pentose sugar in it is Ribose.  
 (b) It contains Adenine, Guanine, Thymine and Cytosine  
 (c) It is present in the nucleoli  
 (d) It may be folded back on itself to give double helical characteristics.
61. rRNA constitutes \_\_\_\_\_ % of the total cellular RNA.  
 (a) 3- 4 % (b) 10-20%  
 (c) 80% (d) 90%
62. There are mainly \_\_\_\_\_ types of tRNA  
 (a) 170 (b) 20  
 (c) 25 (d) 15
63. Most of the cellular secretions are \_\_\_\_\_ in nature.  
 (a) Glycolipids. (b) Glycoproteins  
 (c) Nucleohistones (d) Proteins
64. Which conjugated molecules play important role in gene expression?  
 (a) Glycolipids. (b) Glycoproteins  
 (c) Nucleohistones (d) None of these
65. The survival of an animal depends upon its ability to take some \_\_\_\_\_ from its environment  
 A) Chemicals (b) Hydrocarbons  
 (c) Organic molecules (d) Inorganic molecules
66. Interconversion of carbohydrates, proteins and lipids in living cells are an example of  
 A) Coordinated catabolic activities (b) Coordinated anabolic activities  
 (c) Both A & B (d) Any one
67. Carbon commonly combines with  
 (a) H (b) N & O  
 (c) P & S (d) All of these
68. Non polar organic molecules are \_\_\_\_\_ in water.  
 A) Soluble (b) Insoluble  
 (c) Partially soluble (d) Depends upon condition
69. In living organisms the lubricant which provides protection against damage resulting from friction is  
 A) Carbohydrates (b) Fat  
 (c) Water (d) Protein



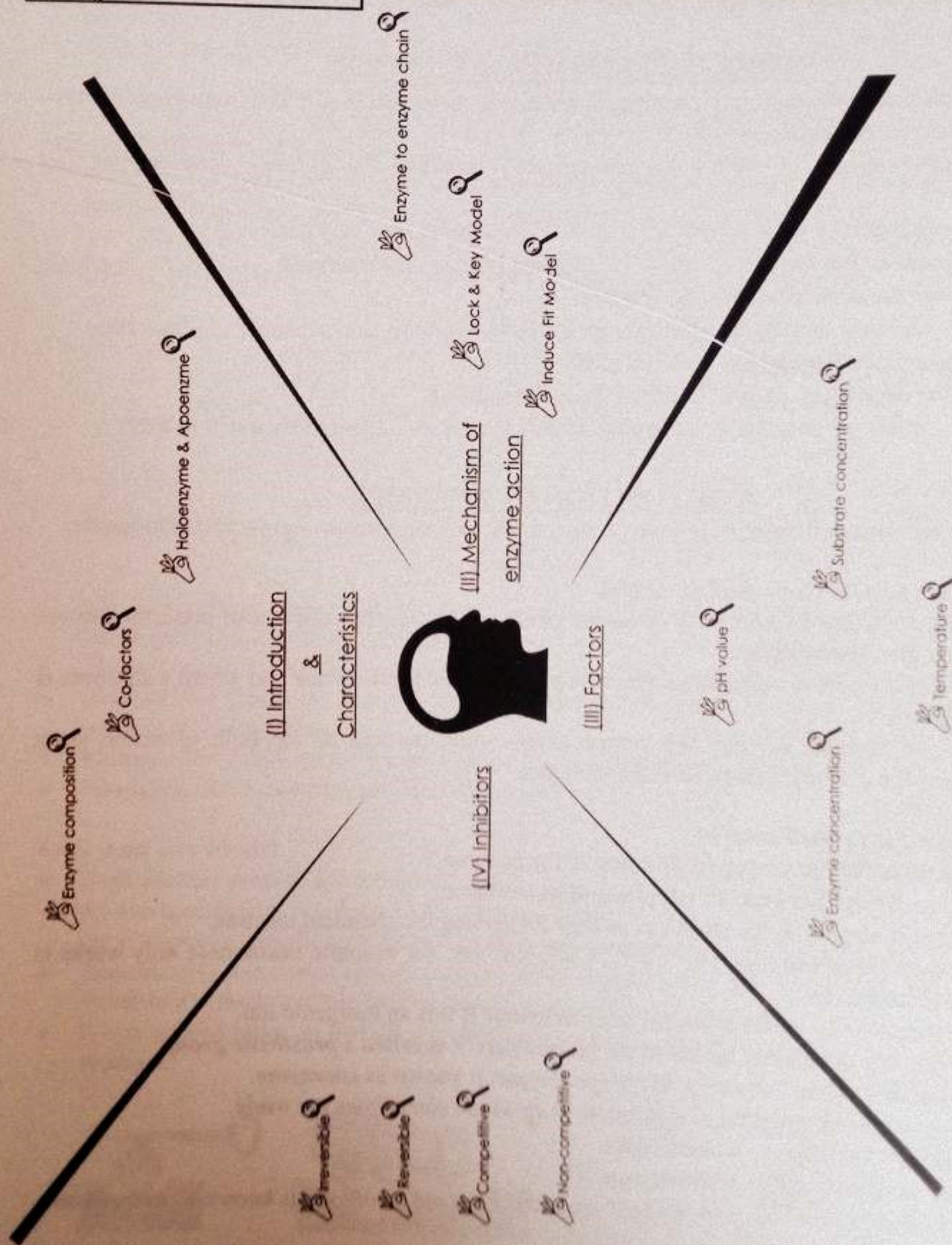


70. In  $C_x(H_2O)_y$ , "x" ranges from  
A) 1 to 3 thousand  
(b) 3 to many thousand  
(c) 3 to 5 thousand  
(d) 5 to 9 thousand
71. Glycolipids and glycoproteins have structural role in the \_\_\_\_\_ matrix of animal and bacterial cell  
A) Extracellular  
(b) Intracellular  
(c) Both of these  
(d) Glucose
72. The trioses which are intermediate in respiration and photosynthesis are  
A) Glyceraldehydes  
(b) Dihydroxy acetone  
(c) Both of these  
(d) None of these
73. Keto group is represented as  
A) CO  
(b) C – COO – C  
(c) HCOH  
(d) HOH
74. The monosaccharide found in some bacteria and occurring rarely are  
A) Trioses  
(b) Hexoses  
(c) Tetroses  
(d) Pentoses
75. How many carbon atoms are required to form a furan ring (ribofuranose)  
A) 3  
(b) 4  
(c) 5  
(d) 2
76. In esterification "OH" comes from  
(a) Organic acid  
(b) Alcohol  
(c) Water  
(d) Sugar
77. Triglyceride is also known as  
A) Natural lipid  
(b) Neutral lipid  
(c) Neutral wax  
(d) All of these
78. Which one is not found in fatty acids in acylglycerols?  
(a) C – 6  
(b) C – 25  
(c) C – 26  
(d) C – 30
79. Animal fats are \_\_\_\_\_ at room temperature  
(a) Liquids  
(b) Gases  
(c) Solids  
(d) None of these



# Chapter 3

## ENZYMES







- **Enzymes** are biological molecules (proteins) which catalyze a biochemical reaction and remain unchanged after completion of reaction is called enzymes.
- A chemical substance with which an enzyme reacts is called a **substrate**.

### CHARACTERISTICS OF ENZYMES

- All are **globular proteins**, having specific chemical composition due their component amino acids and specific shape.
- Even small amount of them can tremendously **increase the efficacy** of a biochemical reaction.
- They are **specific** for each type of a reaction or group of related reactions.
- Their presence does not affect the nature or **properties of end products**.
- They **lower the activation energy** of the reactants.
- They are **sensitive** to even a minor change in pH, temperature and substrate concentration.
- They require **aqueous media** for their activity.
- Some may require **co-factor** for their proper functioning.
- Some enzymes are potentially damaging, if they are manufactured in their active form.

### COMPOSITION OF ENZYMES

Most of the enzymes are made of protein (amino acids) and non-protein (co factor) component.

#### **Protein Part (Apoenzyme - Amino Acids)**

- Enzymes are made of **hundreds of amino acids** joined together and coiled upon themselves to form a globular structure.
- **Active site** is a part of an enzyme where catalytic activities take place and where a substrate is attached.
- Active site consists of only few amino acids, while the rest of the bulk of amino acids maintains the globular structure of the enzyme.

#### **Non- Protein Part (Co- Factor)**

- It is **essential** for the proper functioning of the enzyme.
- It acts as a **bridge** between an enzyme and its substrate.
- Sometime it also provides **chemical energy** for driving the chemical reaction.
- It may be a **metal ion** like,  $Mg^{2+}$ ,  $Fe^{2+}$ ,  $Cu^{2+}$ ,  $Zn^{2+}$  etc. for example hexokinase only works in the presence of  $Mg^{2+}$ .
- The detachable co- factor is known as an **activator** if it is an inorganic ion.
- If a cofactor is covalently bound to the protein part, it is called a **prosthetic group**.
- If a cofactor is loosely attached to the protein part it known as **coenzyme**.
- **Vitamins** act as an essential raw material from which coenzymes are made.
- Enzyme – Co-factor = **Apoenzyme**
- Enzyme + Co-factor = **Holoenzyme**.
- An activated enzyme consisting of polypeptide chain and a cofactor is known as **holoenzyme**.

#### **Location Of Enzymes**

- Some enzymes may be simply **dissolved in cytoplasm** e.g., enzymes of glycolysis.
- Most of them are **tightly bound** to sub- cellular organelles e.g.,



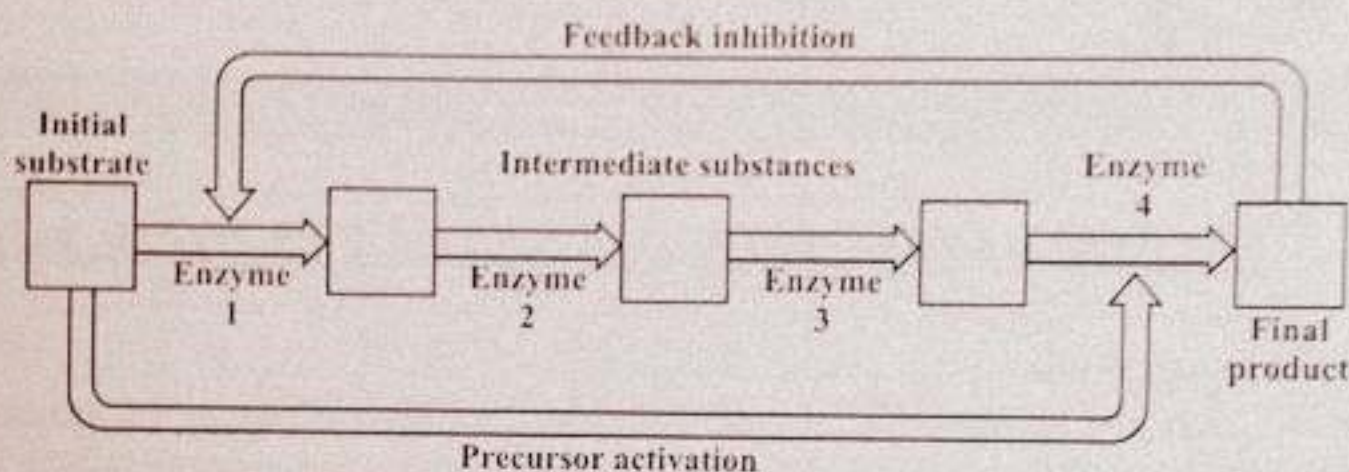
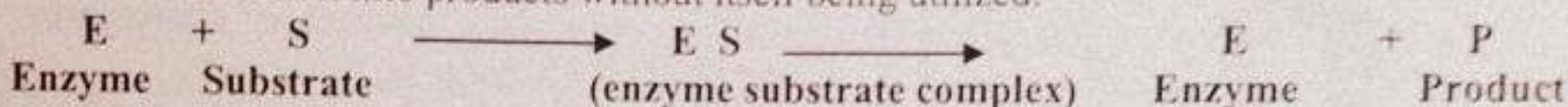


- Enzymes of photosynthesis are found in *chloroplast*.
- Enzymes involved in cellular respiration are present in *mitochondria* attached to its membrane system.
- Enzymes taking part in synthesis of protein are integral part of *ribosome*

### MACHANISM OF ENZYME ACTION

#### Simple Mechanism of Enzyme Action

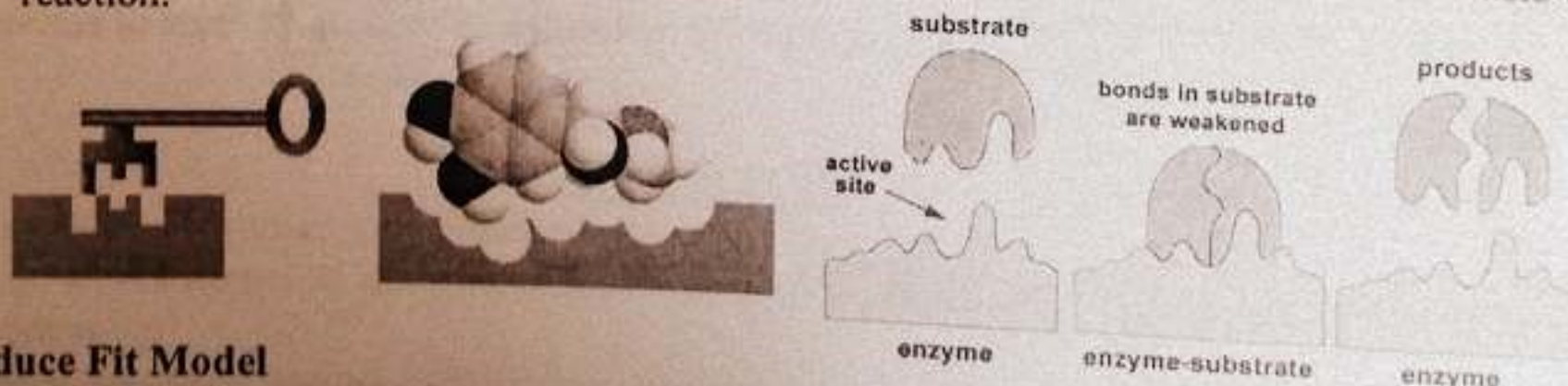
- Enzymes are specific in their action, any enzyme, therefore react with its specific substrate and transform it into products without itself being utilized.



- The **active site** of an enzyme is a three dimensional cavity bearing a specific charge by which the enzyme reacts with its substrate.
- The active site is made of **two definite regions** i.e. binding site & a catalytic site.
- Binding site** helps the enzyme in the regulation and binding of the proper substrate to produce an ES complex.
- Catalytic site** catalyzes the transformation of the substrate into products.
- Formation of **ES complex** activates the catalytic site.

#### Lock And Key Model

- Emil Fischer** proposed this model.
- As one specific key can open a specific lock, In the same manner a specific enzyme can transform a specific substrate into product/s.
- According to this model specific site is a **rigid structure** and thus there is no modification or flexibility in the active site before, during or after the enzyme action.
- It was proved latter on that all the chemical reactions can't be explained on the basis of this reaction.



#### Induce Fit Model

- Koshland** proposed this model.
- It is the **modified form of lock and key model**.





- It states that when a substrate combines with an enzyme, it induces changes in the enzyme's structure. This change in the structure allows the enzyme to carry out its catalytic activity more effectively.



1. A chemical substance with which an enzyme reacts is called a \_\_\_\_\_.
2. Enzymes require \_\_\_\_\_ medium for their activity.
3. \_\_\_\_\_ acts as a bridge between enzyme & substrate.
4. \_\_\_\_\_ act as raw material for coenzymes.
5. Formation of ES complex activates \_\_\_\_\_ site.

### FACTORS AFFECTING THE RATE OF ENZYME ACTION

#### Enzyme Concentration

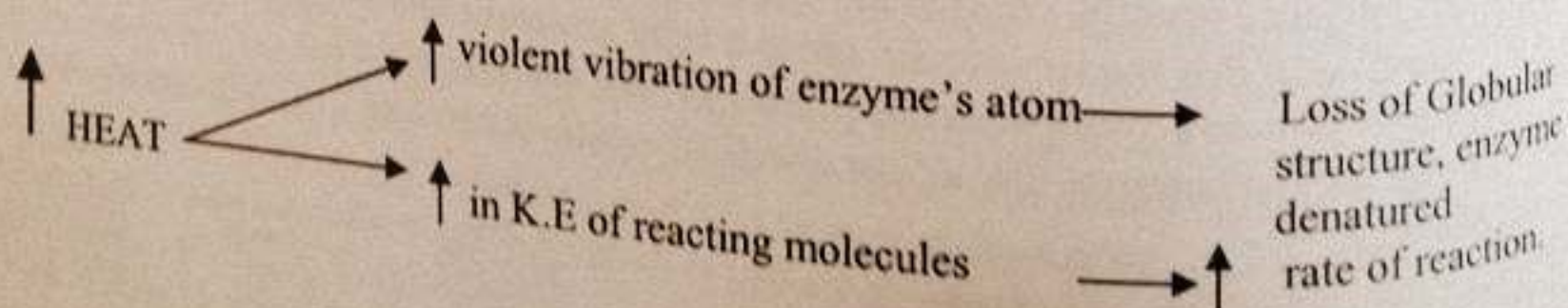
- Rate of reaction is directly proportional to the amount of enzyme present, which in turn determines the number of available active sites for that particular catalytic reaction.
- If the amount of an enzyme is increased by two fold, the reaction rate will be doubled.
- However, after a certain limiting concentration, the rate of the reaction will no longer depend upon the enzyme concentration.

#### Substrate Concentration

Rate of a reaction is directly proportional to the substrate concentration provided that active sites on the enzyme are available.

#### Temperature

- Rate of a reaction increases with an increase in temperature up to certain limits.
- Optimum temperature** is the temperature at which an enzyme works at its maximum rate. e.g., for enzymes of our body it is  $37^{\circ}\text{C}$ .



Answers: (1) Substrate (2) Aqueous (3) Co-factor (4) Vitamins (5) Catalytic



pH Value

- Optimal pH

Change in  
Amino

- Extreme change in pH leads to denaturation

#### ENZYME

Pepsin
Sucrase
Enterokinase
Salivary Amylase
Catalase
Chymotrypsin
Pancreatic lipase
Arginase

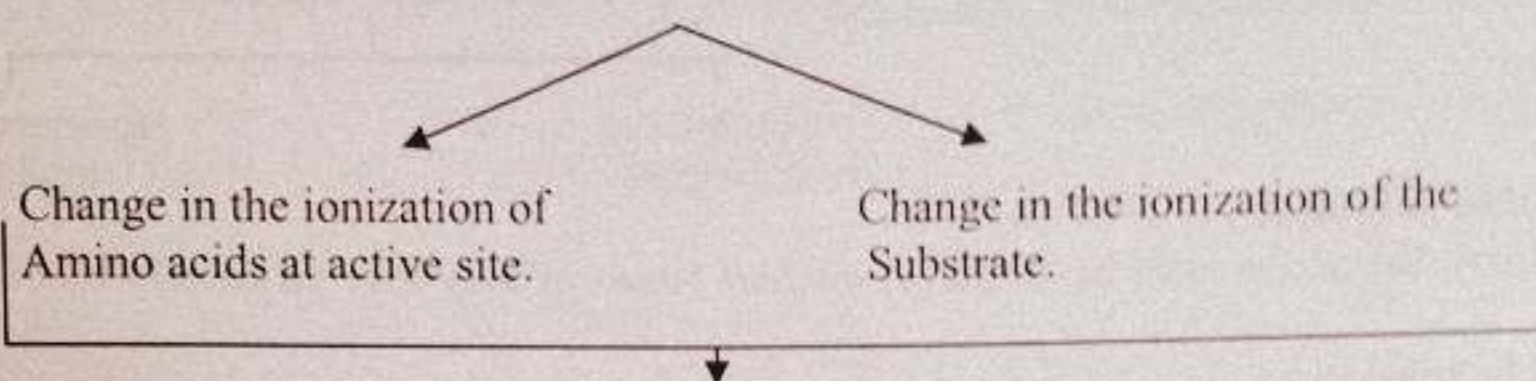
- An inhibitor but it is not permanent.
- Examples include...
- They are of two types...



## pH Value

- **Optimal pH** is the range of pH at which an enzyme functions acts most effectively.

Slight Change In Ph

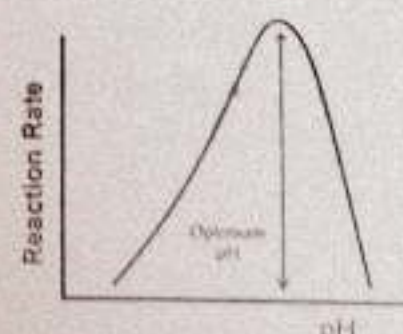
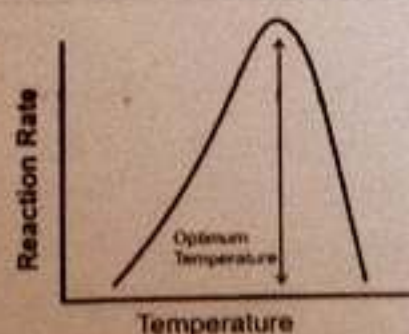
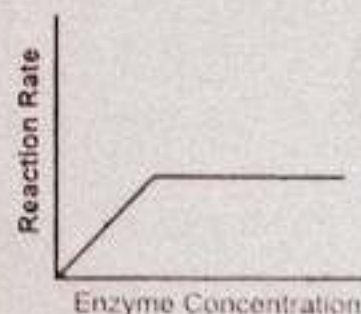
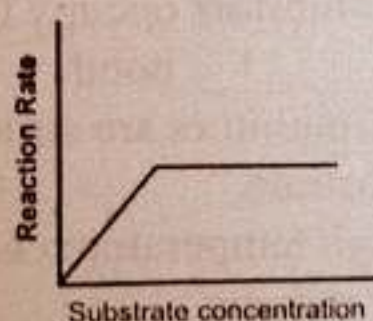


Enzyme Activity Is Retarded Or Blocked

- **Extreme changes in pH** cause the bonds in the enzyme to break, resulting in the enzyme denaturation.

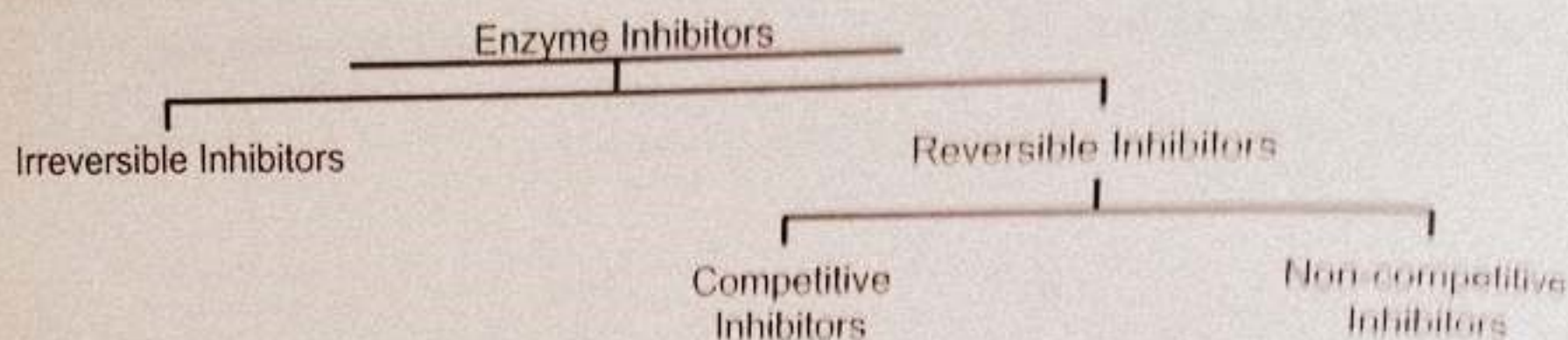
ENZYME	FUNCTION	pH VALUE
Pepsin	Digestion of proteins	2.00
Sucrase	Hydrolysis of sucrose	4.50
Enterokinase	Activation of trypsinogen	5.50
Salivary Amylase	Digestion of carbohydrate	6.80
Catalase	Decomposition of hydrogen peroxide	7.60
Chymotrypsin	Involved in proteolysis	7.00-8.00
Pancreatic lipase	Hydrolysis of fats	9.00
Arginase	Catalysis of arginine into urea	9.70

## Factors Affecting Enzyme Action

INHIBITORS

- An **inhibitor** is a chemical substance which can react (in place of substrate) with the enzyme but it is not transformed into product/s and thus blocks the active site temporarily or permanently.
- **Examples** include cyanide, antibiotics, anti-metabolites, drugs.
- They are of **two types** of inhibitors i.e. reversible and irreversible inhibitors.



**Irreversible Inhibitor**

They occupy the active sites by forming *covalent bonds* or they may physically block the active sites.

**Reversible Inhibitors**

- They form *weak linkage* with the enzyme.
- Their effect can be neutralized, completely or partially by increase in the concentration of the substrate.
- They are *two types* of reversible inhibitors i.e. competitive and non-competitive.
- **Competitive inhibitors** are structurally similar to the substrate, hence can bind to the active site but can't activate the catalytic site, thus no products are formed.
- **Non-competitive inhibitors** bind with the enzyme at the site other than active site. Structure of enzyme is altered, so that even a genuine substrates binds the active site, catalysis fails to take place.



1. Optimum temperature for enzymes of our body is \_\_\_\_\_
2. Optimum pH for pepsin is \_\_\_\_\_
3. Irreversible inhibitors occupy the active site by forming \_\_\_\_\_ bond.
4. \_\_\_\_\_ inhibitors are structurally similar to substrate.
5. Extremely high temperature can cause \_\_\_\_\_ of enzyme.

Answers: (1) 37°C (2) 2 (3) Covalent (4) Competitive (5) Denaturation





## PRACTICE EXERCISE



1. **Biological molecules (proteins) which catalyze a biochemical reaction and remain unchanged after completion of reaction are called**  
 (a) Cofactor. (b) Coenzymes.  
 (c) Activator (d) Enzymes
2. **Which statement about enzyme is incorrect:**  
 (a) Some of them consist solely of protein, with no non protein part.  
 (b) They catalyze a chemical reaction without being utilized.  
 (c) All enzymes are fibrous Proteins.  
 (d) They without their cofactor are called apoenzyme.
3. **In which of the following location enzymes controlling cellular respiration are present?**  
 (a) Nucleus (b) Chloroplast.  
 (c) Mitochondria (d) Ribosome.
4. **An activated enzyme consisting of polypeptide chain and a cofactor is called:**  
 (a) Apoenzyme. (b) Holoenzyme  
 (c) Activated enzyme (d) Both b and c
5. **Which one forms the raw material for coenzymes?**  
 (a) Vitamins (b) Carbohydrates.  
 (c) Proteins (d) Metals.
6. **A cofactor made of inorganic ion which is detachable is called**  
 (a) Prosthetic group. (b) Coenzyme.  
 (c) Activator. (d) Cofactor
7. **Enzymes \_\_\_\_\_ the activation energy of a chemical reaction**  
 (a) Increases.  
 (b) Decreases  
 (c) Doesn't effect.  
 (d) Increases or decreases depending upon individual enzyme.
8. **A three dimensional cavity bearing a specific charge by which the enzyme reacts with its substrate is called**  
 (a) Active site (b) Binding site  
 (c) Catalytic site (d) Allosteric site
9. **Which step causes activation of catalytic site of an enzyme?**  
 (a) Change in pH of the surroundings.  
 (b) Formation of Enzyme Substrate complex.  
 (c) Change in the charge of the active site.  
 (d) Change in temperature
10. **Lock and Key model was proposed by**  
 (a) Emil Fischer (b) Koshland.  
 (c) Robin Williams (d) Rudolph Virchow
11. **Which statement is incorrect about Lock and Key Model?**  
 (a) Specific enzyme can transform only a specific substrate.  
 (b) Active site of an enzyme is a non flexible structure.  
 (c) Active site does not change before, during or even after the reaction.  
 (d) It explains the mechanism of every chemical reaction.





12. The rate of a reaction is directly proportional to the concentration of an enzyme, which statement is incorrect in this respect:
- Increase in enzyme molecule increases the available active sites.
  - This relation is for unlimited time period with unlimited enzyme concentration
  - If the concentration is doubled the rate will become two fold.
  - None of these
13. If the concentration of enzyme is kept constant, and amount of substrate is increased, a point is reached where increase in substrate's concentration doesn't affect the reaction rate because of
- Enzymes get denatured at higher substrate conc.
  - Rate of reaction is indirectly proportional to substrate concentration at this point.
  - All the active sites on enzyme molecule are occupied.
  - None of these
14. If more substrate to already occurring enzymatic reaction is added, more enzyme activity is seen because:
- There is probably more substrate present than there is enzyme.
  - There is probably more enzyme available than there is substrate.
  - There is probably more product present than there is either substrate or enzyme.
  - The enzyme substrate complex is probably failing to form during the reaction.
15. If more substrate to already occurring enzymatic reaction is added, and there is no effect on the rate of the reaction, what is the form given to this situation:
- Saturation
  - Denaturation
  - Composition
  - Inhibition.
16. The active site of an enzyme:
- Never changes
  - Forms no chemical bond with substrate
  - Determined by structure and the specificity of the enzyme.
  - They are non specific in their action.
17. Excessive increase in temperature of medium causes the enzyme molecule to
- Activate
  - Unaffected
  - Denatured
  - None of these
18. Extreme change in pH results in:
- Change in ionization of amino acids at the active site of the enzyme.
  - Change in the ionization of the substrate.
  - Denaturation of the enzyme
  - Increase in the reaction rate.
19. Optimal temperature of enzymes present in human body is
- 27°C
  - 37°C
  - 47°C
  - 30°C
20. A chemical substance which can react (in place of substrate) with the enzyme but is not transformed into product/s and thus blocks the active site temporarily or permanently is called
- Co-enzyme
  - Blocker
  - Inhibitor
  - Cofactor
21. Inhibitors which block the enzyme by forming weak bond are called
- Competitive inhibitors.
  - Non-competitive inhibitors.
  - Irreversible inhibitors.
  - Both a and b





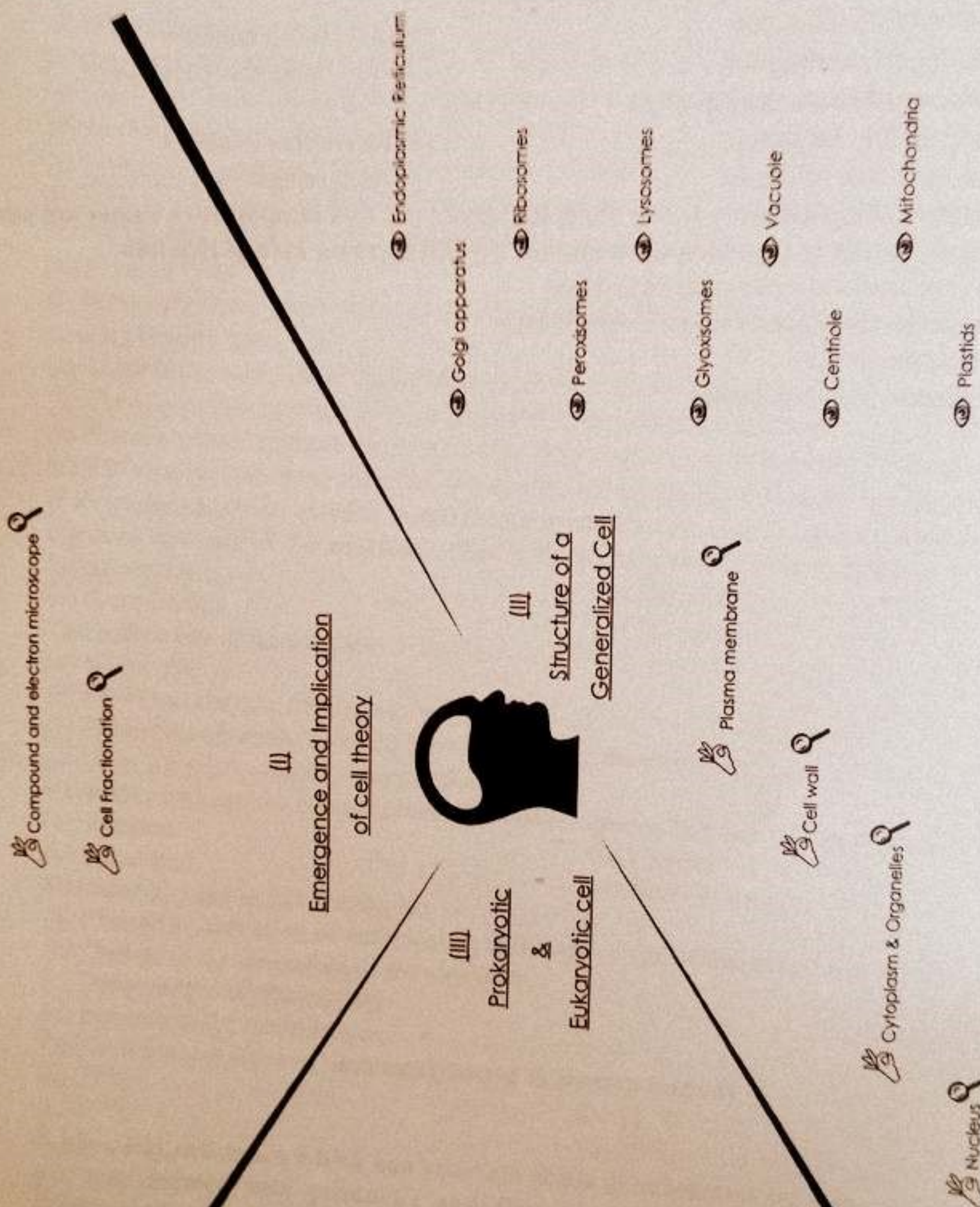
22. A substance which binds at the active site of the enzyme but doesn't result in the formation of the products is called:
- (a) Irreversible inhibitor
  - (b) Reversible inhibitor
  - (c) Competitive inhibitor.
  - (d) Non-competitive inhibitor.
23. The structure of an enzyme is altered by:
- (a) Irreversible inhibitor
  - (b) Reversible inhibitor
  - (c) Competitive inhibitor.
  - (d) Non-competitive inhibitor.
24. Malonic acid is an example of:
- (a) Irreversible inhibitor
  - (b) Reversible inhibitor
  - (c) Competitive inhibitor.
  - (d) Non-competitive inhibitor.
25. If enzyme concentration is low than substrate, pH and temperature values are equal to requirement then which of the following will increase rate of reaction.
- (a) increase in concentration of enzyme
  - (b) increase in concentration of substrate
  - (c) increase in pH.
  - (d) increase in temperature



Chapter

4

# THE CELL





*Cell* is a structural and functional unit of life.

### EMERGANCE AND IMPLICATION OF CELL THEORY

Contribution of various scientists in discovery of cell is as follows:

SCIENTISTS	CONTRIBUTION
Robert Hook	Was the first who discovered and named the cell, by studying a thin section of cork. Published the report in "micrographia" He stated: cell is an empty space bounded by thick wall.
Lorenz Oken	Believed, "all living beings originate from or consist of vesicles or cells."
Jean Baptist de- Lamarck	Expressed "no body can have life if its constituent parts are not cellular tissue or formed by cellular tissue."
Robert Brown	Reported the presence of nucleus, thus changed the ideas about the cell being an empty space.
Theodor Schwann and Schleiden	Presented cell theory.
Rudolph Virchow	Opposed the ideas of abiogenesis and hypothesized "omnis cellula e cellula", meaning, new cells are formed only by division of previously existing living cells.
Louis Pasteur	Provided experimental proof for Virchow's hypothesis by demonstrating that microorganisms (bacteria) could be formed only from existing bacteria.
August Weismann	Stated "all presently living cells have a common origin because they have basic similarities in structure and molecules."

### CELL THEORY

According to cell theory

- A cell consists of **three basic parts** i.e., the nucleus, the cytoplasm which surrounds the nucleus, and thin outer covering or membrane (plasma membrane)
- The **cell wall** according to them is an additional structure, present only in the plant cell.
- All living organisms are composed of **one or more cells**.
- All cells arise from **pre-existing cells**.
- Cell is the **basic** structural as well as functional **unit** for all the organisms.



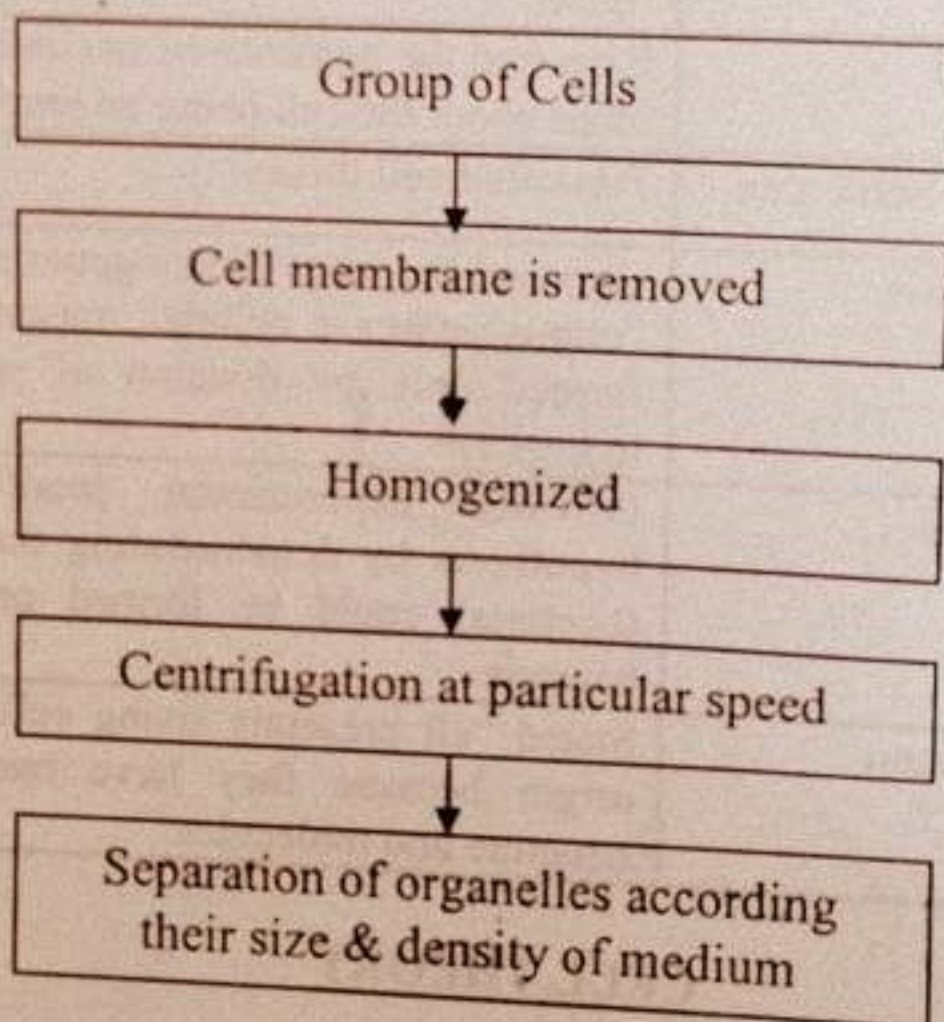
MICROSCOPES

- The *human naked eye* can differentiate between two points, which are at least 1.0 mm apart, called resolution of the eye.
- Commonly there are two types of microscope:

FEATURE	COMPOUND MICROSCOPE	ELECTRON MICROSCOPE
Source of Illumination	Light	Beam of electron
Resolution Power	2.0 $\mu\text{m}$	2-4 Å (Angstrom)
Magnifying Power	500X (by multiplying X value of ocular lens and X value of objective lens).	250,000X (X=Times)
Image Observation	By eye piece	By screen

CELL FRACTIONATION

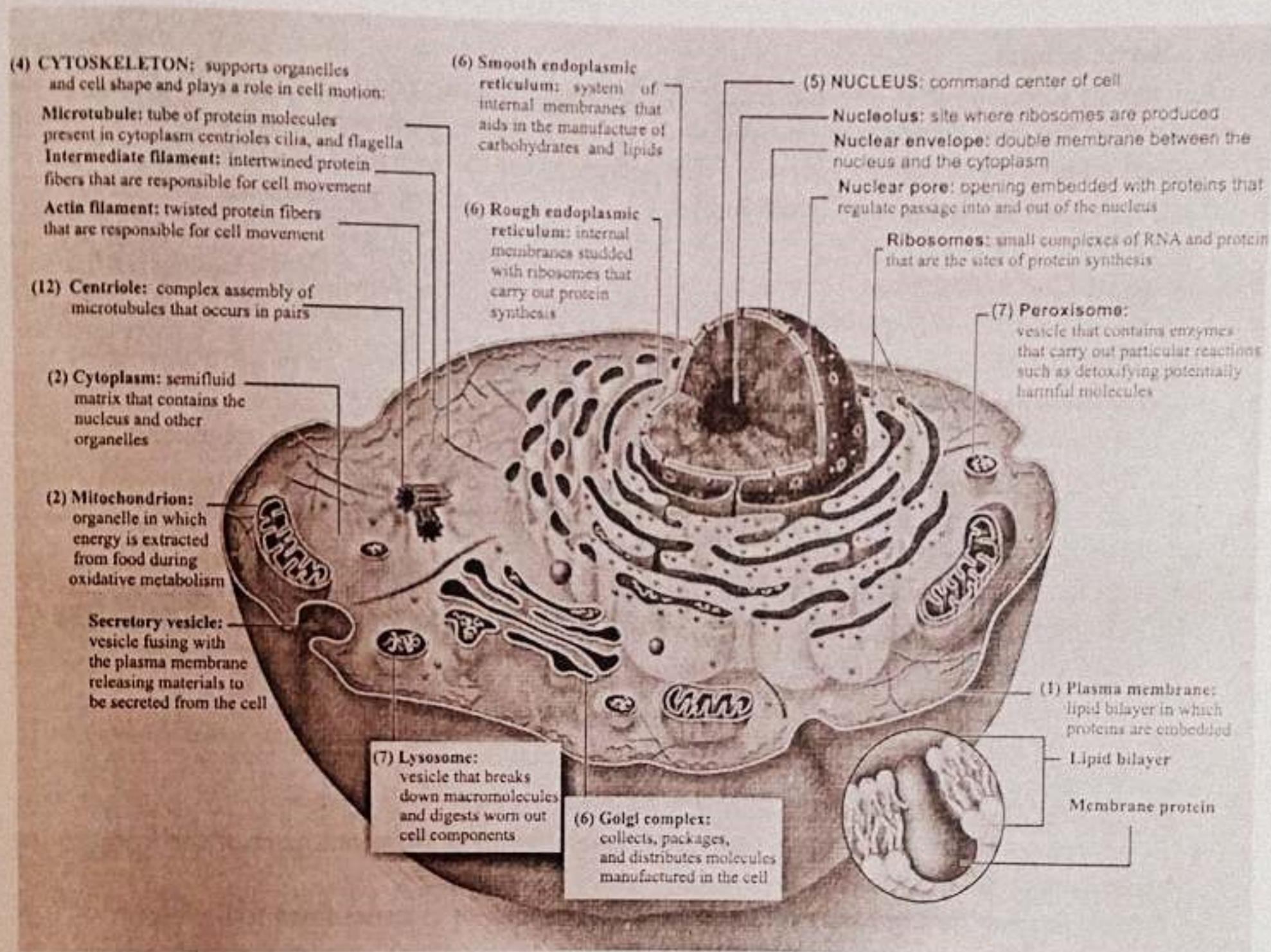
*Cell fractionation* is a technique by which various components of cell including its organelles can be isolated.

STRUCTURE OF A GENERALIZED CELL

Organelles without membrane	Organelles with single membrane	Organelles with double membrane
<ul style="list-style-type: none"> <li>Ribosomes</li> <li>Centrosomes</li> </ul>	<ul style="list-style-type: none"> <li>Lysosome</li> <li>Golgi complex</li> <li>Endoplasmic reticulum</li> </ul>	<ul style="list-style-type: none"> <li>Mitochondria</li> <li>Plastids</li> <li>Nucleus</li> </ul>



- Flagella, centriole and lysosomes are not found in most of the *plant cells*.
- Cell wall, central vacuole and chloroplast are not found in most of *animal cells*.



## PLASMA MEMBRANE

Cell membrane is the outer most boundary of the animal cell while covered by cell wall in a plant cell.

### Chemical Composition

Chemically composed of:

- **Proteins** (60- 80 %)
- **Lipids** (20- 40 %)
- Small amount of carbohydrates

### Structural Organization

#### A Unit Membrane

- Initially the cell membrane was considered as a *lipid bilayer* sandwiched between inner and outer layer of protein.





- This structure has **hydrophobic component** i.e. central non-polar part of phospholipids molecule and a **hydrophilic part** i.e., out polar component of phospholipid + globular protein.
- **Modern technology** has revealed that lipid bilayer is not sandwiched between protein layers.

### Fluid Mosaic Model

- According to this model, protein molecules instead of being continuous and covering to the surface of the membrane are embedded in lipid layers in a mosaic manner. These protein molecules may function as a gateway (charged pore) for the transport of materials.
- This at present is the most accepted model.

### Functions Of Cell Membrane

- Cell membrane is a **differentially permeable** or selectively permeable membrane, allowing only the selective substances to pass through it.
- **Lipid soluble substances** pass the cell membrane more **easily** than others.
- **Small gas molecules, water, glucose** etc. being neutral can **easily** cross.
- **Ions** being charged particles have some **difficulty** in crossing.
- Movement of material across the cell membrane which don't requiring expenditure of metabolic energy is called **passive transport**.
- Movement of substances against the concentration gradient (from lower to higher concentration) which requires energy, provided in terms of ATP is called **active transport**.
- Intake of materials along the infoldings of cell membrane in the form of vacuole is called **endocytosis**.

#### Phagocytosis

(To engulf solid particles)

#### Pinocytosis

(To take liquid material)

- In neurons, the cell membrane **transmits nerve impulses** from one part of the body to the other to keep coordination.
- It provides **mechanical support** to the protoplasm and an external form to the cell.

## CELL WALL

It is the outer most layer of plant cell.

### Structural Organization

- It is composed of three main layers i.e. primary wall, secondary wall and middle lamella.
- **Middle lamella** is first to be formed in between the primary walls of neighboring cells.
- Primary wall is a true wall composed of cellulose, pectin and hemicellulose.
- Cellulose is arranged in criss-cross manner. It forms the major strengthening material of cell wall in plant cells.
- **Secondary wall** is formed on inner surface, comparatively thick and rigid. Chemically it is composed of inorganic salts, waxes, cutin and lignin.

ORGANISM	CELL WALL
Bacteria	Pepidoglycan and lipopolysaccharides (lipoprotein complex)
Blue green algae	Muramic acid
Fungi	Chitin





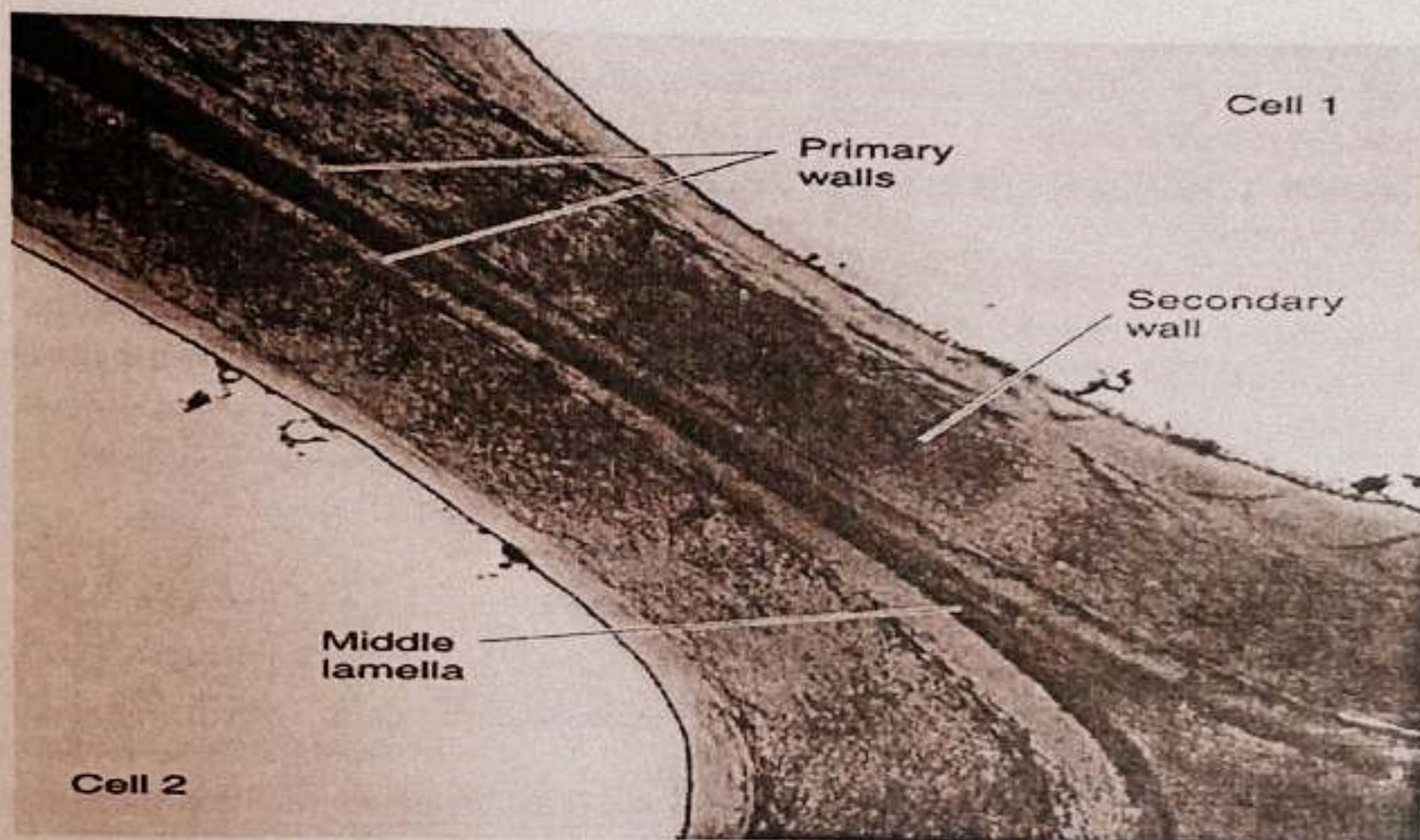
## Chapter 4

## The Cell

Algae and other plants	Mainly cellulose
Fungi like protists	Cellulose
Archaeobacteria	Proteins, Glycoproteins, Polysaccharides

### Function

- It provides definite shape to the cell and keeps it rigid
- It doesn't act as a barrier to the material passing through it.



1. \_\_\_\_\_ provided experimental proof for Virchow's hypothesis.
2. Pick non-membranous from ribosome, peroxisome, lysosome & glyoxisome?
3. \_\_\_\_\_ is most important model of cell membrane.
4. \_\_\_\_\_ transport uses ATP.
5. \_\_\_\_\_ is arranged in criss cross manner in plant cell wall.

Answers: (1) Louis Pasteur (2) Ribosome (3) Fluid mosaic (4) Active (5) Cellulose





## Chapter 4

CYTOPLASM

- An aqueous ground substance containing a variety of cell organelles and other inclusions such as insoluble waste and storage products is called *cytoplasm*.
- Cytoplasm + Nucleus = *Protoplasm*.
- It exhibit *streaming movements* i.e., active mass movement of cytoplasm.

**Chemical Composition**

- The soluble part of cytoplasm, which forms its ground substance is called *cytosole*.
- Chemically it is **90% water**.
- *Fundamental molecules of life and ions* either for true solution, while larger molecules form colloidal solution.

Sol (non- viscous) ————— Gel ( viscous).... Mostly in peripheral part of the cell.

- *Cell organelles* like endoplasmic reticulum, ribosomes, mitochondria etc are also present in cytoplasm

**Functions**

- It acts as a *store house* of vital chemicals.
- It is the site of certain *metabolic processes* like glycolysis.

ENDOPLASMIC RETICULAM

- *Network of interconnected channels* extending and often continues with cell membrane to the nuclear membrane is called endoplasmic reticulum.

**Structural Organization**

- They *vary in appearance* from cell to cell.
- *Cisternae* are spherical or tubular membranes which separate the material present in these channels from that of cytoplasmic material.

**Morphological Forms**

- *Rough E.R* = One with ribosomes attached to its external surface.
- *Smooth E.R* = One without ribosomes.

**Functions**

They provide *mechanical support* to the cell, so that its shape is maintained

**Rough Endoplasmic Reticulum**

- They are involved in the *synthesis of proteins*.
- After synthesis, they are either stored in the cytoplasm or transported out of the cell through these channels.

**Smooth Endoplasmic Reticulum**

- They help in *metabolism* of various types of molecules particularly lipids.





- They help in *detoxifying harmful drugs*.
- They are also responsible for the *transmission of impulses* e.g., in muscles cells and nerve cells.
- They are also involved in *transport of materials* from one part of the cell to the other.

### RIBOSOMES

- **Palade** was the first person to study ribosome.
- Ribosomes are assembled in the *nucleolus* from where they are transported to the cytoplasm through nuclear pores.
- Ribosomes are *ribonucleo- proteins* i.e., consists of mRNA and proteins.
- They exist in *two forms*, either dispersed in the cytoplasm or attached with endoplasmic reticulum as tiny granules.
- Eukaryotic ribosomes consist of *two subunits*: larger subunit sediments at 60S while the smaller at 40S (S= Svedberg unit used in ultracentrifugation, signifies sedimentation rate.)
- Both attach to form *80 S particles*, which are controlled by  $Mg^{2+}$  ions.
- Ribosomes are attached to 5' end of mRNA through smaller subunits.
- A group of ribosomes attached to mRNA is known as *polysome*.

### GOLGI APPARATUS

- They were first discovered by *Golgi*.
- Golgi apparatus in plants is called *Dictyosomes* which are used in construction of cell wall.

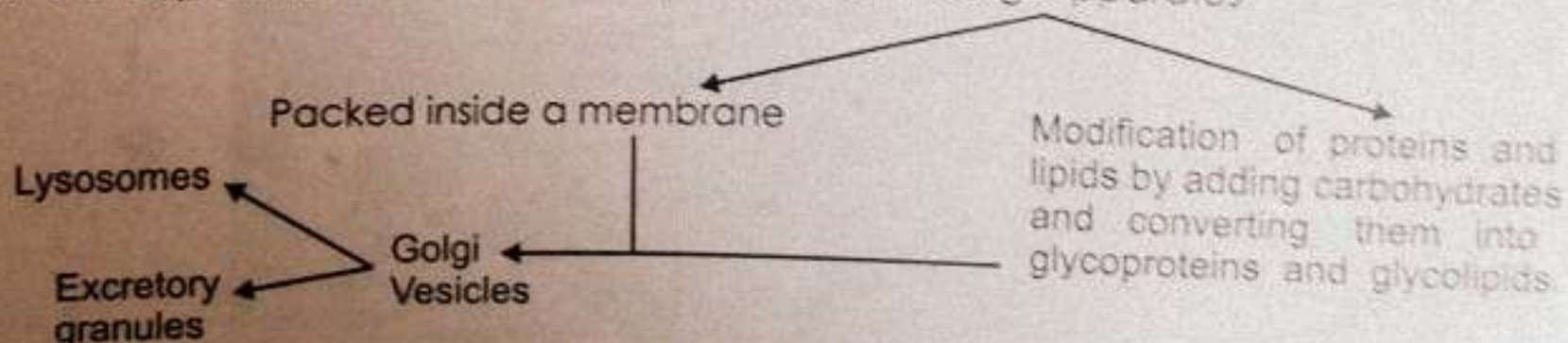
#### Structural Organization

- Golgi apparatus is a stack of flattened, membrane bounded sacs called *cisternae*.
- Golgi complex is a complex system of interconnected tubules around the central stacks. The cisternae together with associated vesicles are called *Golgi complex*.
- **Vesicles** budded off from smooth endoplasmic reticulum are fused together to form cisternae of golgi apparatus.
- Golgi apparatus has *two faces* i.e. forming face and maturing face.
- **Forming face** is outer convex surface and **maturing face** is inner concave surface.
- **Secretory granules** are pinched off from maturing surface.

#### Function

- They are concerned with the *cell secretion*.
- Passage of secretions

Ribosomes → Endoplasmic reticulum → Transport vesicles → Golgi apparatus







## Chapter 4

LYSOSOMES

- They were first discovered by *De Duve*.
- Word lysosome is composed of two words, '*Lyso*' means '*splitting*' and '*soma*' means '*body*' thus these are intracellular organelles involved in digesting the phagocytosed food particles and other digestive activities.

**Structural Organization**

- Bounded by a *single membrane*.
- Contain *enzymes* synthesized on RER and further processed in Golgi apparatus, like acid phosphatase and other hydrolytic enzymes.

**Functions**

Food particles engulfed as phagocytosed vacuole fuse with the primary lysosome (processed enzymes budded off as golgi vesicles) and form a digestive vacuole called secondary lysosome.

- Lysosomes are abundant in cells involved in *phagocytosis*.
- Old, worn out parts of cell are digested by lysosomes as recycling and renovating process. This is called *autophagy* (self eating).
- *Degeneration of cell* may be carried by lysosomes during some developmental processes.
- *Extracellular digestion* also occurs by secreting extracellular enzymes.

**Clinical Importance Of Lysosomes**

*Mutation* in lysosomal enzymes, which is involved in catabolism of a certain substance may result in abnormal accumulation in body cells resulting in *storage diseases*. 20 such diseases are known.

- *Glycogenosis type II* is an inborn error of metabolisms, resulting from absence of lysosomal enzyme alpha galactosidase involved in digestion of glycogen into glucose. It results in glycogen accumulation in liver and muscles.
- *Tay- Sach's disease* is accumulation of lipids in brain cells, resulting from absence of enzymes that catabolize lipids, leading to mental retardation.





PEROXISOMES

- They were first discovered by *De Duve* and co-workers.
- They are called peroxisomes, since involved in *formation and decomposition of hydrogen peroxide* in the cell, thus contain  $H_2O_2$  – producing oxidases and catalases.
- Specially found in cells and tissues containing oxidative enzymes like *peroxidase, catalase, glycolic acid oxidase*.
- They have *single membrane* and are approximately  $0.5\mu m$  in diameter.
- They are present in animal, plant, protozoa and yeast cells.
- Also take part in photorespiration in plants.

GLYOXISOMES

- They are present *only in plant cells*.
- They contain enzymes which help in *Glyoxylate Cycle* (The process of conversion of fatty acids into carbohydrates).
- They are *abundant in plant seedlings*, which utilize fatty acids to generate energy for formation of a new plant.
- They appear for only a short period of *germination of seeds*.
- They are abundant in *lipid rich seeds* like castor bean and soyabean but absent in lipid poor seeds such as the pea.

VACUOLES

- They are present both in plant and animal cell.
- *In plant cell*, a large central vacuole is present that is formed by coalescence of smaller vacuoles.
- *In animal cell*, small but numerous vacuoles are present.

**Function**

- They serve to *expand* the plant cells without diluting their cytoplasm
- They act as site for *storage* of water and cell products or metabolic intermediates.
- They *maintain* the cells' turgor, responsible for support, and rigidity of the leaves and young parts of the plants.



1. Most abundant component of cytosol is \_\_\_\_\_.
2. 80S particles are \_\_\_\_\_.
3. Out of Golgi bodies & ER, which are made of cisternae?
4. \_\_\_\_\_ storage disease causes mental retardation.
5. \_\_\_\_\_ appear for short period during germination of seed.

Answers: (1) Water (2) Ribosome (3) Both (4) Tay Sachs (5) Glyoxisomes





## Chapter 4

## CYTOSKELETON

- Cytoskeletal structures include microtubules, microfilaments and intermediate filaments.
- *Major proteins* involved are tubulin, actin, myosin and tropomyosin.

FEATURE	MICROTUBULES	MICROFILAMENTS	INTERMEDIATE FILAMENTS
Size	Long, Unbranched and slender.	Short, Slender	Diameter between both types
Protein	Tubulin	Actin, Myosin	Keratin
Role	<ul style="list-style-type: none"> <li>• Assembly &amp; disassembly of spindles during mitosis</li> <li>• Form Cilia, flagella, basal bodies and centrioles.</li> </ul>	<ul style="list-style-type: none"> <li>• Internal cell motion</li> <li>• Cyclosis</li> <li>• Amoeboid movement</li> </ul>	<ul style="list-style-type: none"> <li>• Maintenance of cell shape</li> <li>• Integration of cellular compartments.</li> </ul>

CENTRIOLE

- They are *present* in animal cells, microorganisms and in lower plants.
- They are *absent* in higher plants.

**Structural Organization**

*Cross section* shows an array of 9 microtubules, each composed of 3 tubules called triplet of tubule.

**Function**

- Before cell division, they replicate and move to opposite poles developing *spindle fibers*.
- They decide location of furrowing during *cell division*.
- They also help in the formation of *cilia*.

MITOCHONDRIA

- They are also called *power house* of the cell.
- They are *self replicating organelles*.
- Their *size and number* varies depending on the physiological activity of the cell.
- They also contain *DNA and ribosome*, thus some proteins may also synthesize in them.

**Structural Organization**

- When seen *under compound microscope* they appear as vesicles, rods, filaments.
- When seen *under electron microscope*, then it shows that they are bounded by two *membranes*, a smooth outer membrane and an inner one forming infoldings (*cristae*) in mitochondrial matrix.
- The inner surface of these cristae contains small knob like structure i.e. *F<sub>1</sub> particles*.





- **Mitochondrial matrix** contains enzymes, co-enzymes and organic and inorganic salts.

### Functions

- They manufacture and supply of **energy** to the cell.
- Enzymes in mitochondrial matrix help in metabolic processes like, **Kreb's cycle, aerobic respiration, and fatty acid metabolism**. These processes extract energy from the organic food and convert them into ATP, an energy rich compound, which provides energy to the cell on demand.
- The spent energy in the form of ADP is regenerated by mitochondria into **ATP**.
- In plants, it is also involved in photorespiration.

### PLASTIDS

- These are membrane bounded mostly pigment containing bodies present only in **plant cells**.
- There are **three main types** of plastids.

FEATURE	CHLOROPLASTS	CHROMOPLASTS	LEUCOPLASTS
Colour of pigment	Green	Other than Green	Colourless
Location	Green parts of the plant.	Petals of the flower and in the ripened fruits.	Underground parts of the plant.
Morphology	Double membrane containing matrix and thylakoids	-	Triangular, tubular or of some other shape.
Main Function.	Absorbs the light energy and utilize it to manufacture food.	<ul style="list-style-type: none"> <li>• Impart colour to different parts.</li> <li>• Help in pollination</li> <li>• Dispersal of seeds.</li> </ul>	Storage of food.

### Chloroplasts

- Chloroplasts vary in their shape and size with a diameter of **4- 6  $\mu\text{m}$** .
- Under light microscope they are **heterogeneous structures** with small granules called grana embedded in the matrix.
- **Envelop** is double membrane covering.
- **Stroma** covers most of the volume of the chloroplast, contains proteins, some ribosomes and small circular DNA. Here  $\text{CO}_2$  is fixed to manufacture sugar. Proteins are also synthesized here.
- **Thylakoids** are flattened vesicles which arrange themselves to form grana and intergrana.
- **GRANA** are piles of thylakoids stacked on each other like coins.
- **50 or more** thylakoids pile to form one granum.
- On these layers **chlorophyll molecules** are arranged, thus appear green.
- **Intergrana** is a non- green part which interconnects grana.



NUCLEUS

- These are most important organelles of the cell.
- They are visible only in non-dividing cells.
- In animal cell they are central in position.
- In plants cells they are pushed to periphery due to large central vacuole.
- They may be regular or spherical in shape.
- A cell containing single nucleus is called mononucleate, two as binucleate and many as multinucleate.
- It contains DNA, RNA and proteins including enzymes.

**Structural Organization**

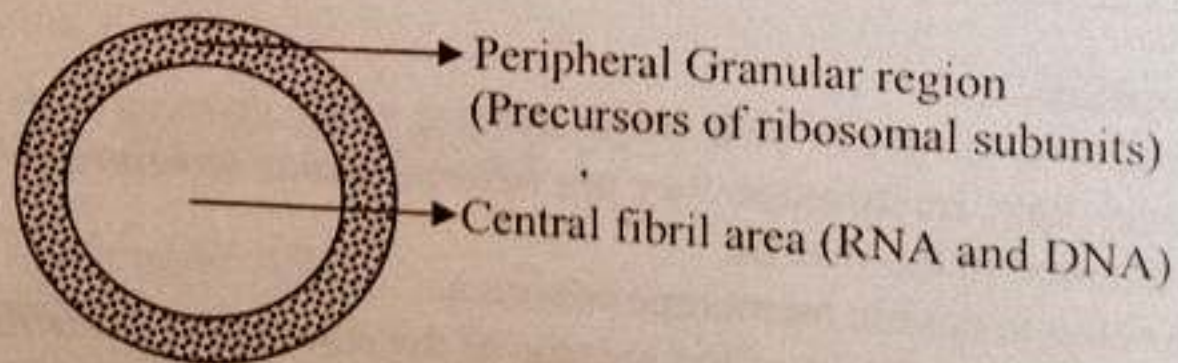
Composed of nuclear membrane, nucleoli, nucleoplasm and chromosomes or chromatin network.

**Nuclear Membrane**

- It separates the nuclear material from the cytoplasm.
- It is a double layered structure. Outer layer continuous with the endoplasmic reticulum and the inner one encloses the nuclear contents.
- **Nuclear pores** results from the fusion of outer and inner membranes. They act as a gateway for the exchange of materials with the cytoplasm. Their number is variable depending upon the differentiation of the cell i.e. undifferentiated cells like an egg has about 30,000 pores / nucleus while erythrocyte a well differentiated one has 3- 4 pores/nucleus.

**Nucleolus**

- It is non membranous, darkly stained body inside the nucleus.
- Nucleoli may be one or more.
- rRNA is synthesized and stored in it.
- Nucleolus is composed of two regions

**Chromosomes**

- Each chromosome is a thread like structure resulting from organization of chromatin material during cell division.
- Under compound microscope they appear to be made of arms (chromatids) and a centromere, the place where spindle fibers are attached during cell division.
- Centromere is the place on the chromosome and **Kinetochores** are places on centromere where spindle fibres are attached during cell division.
- Chemically chromosomes are composed of DNA and protein.



PROKARYOTIC AND EUKARYOTIC CELL

DIFFERENCE	PROKARYOTE	EUKARYOTE
1) Cell Type	They are composed of prokaryotic cells.	They are composed of eukaryotic cells.
2) Nucleus	Nucleus is absent in them.	They have well defined nucleus.
3) DNA	DNA is without any nuclear membrane covering and is directly submerged in cytoplasm.	DNA is enclosed inside the nucleus.
4) Membrane-Bounded Structures	Membrane-bounded structures are absent.	Membrane-bounded structures are present.
5) Ribosomes	They have small sized 70S ribosomes (50S+30S)	They have large sized 80S ribosomes (60S+40S)
6) Cell Wall	Their cell wall is composed of polysaccharide chain covalently bonded with shorter chains of amino acids forming peptidoglycan or murein. Sacculus: a single huge molecule or molecular complex, often representing the entire prokaryotic cell wall.	Cell wall of plants is generally composed of cellulose.
7) Cell Division	They reproduce by binary fission.	They reproduce by mitosis and meiosis.
8) Histone Proteins	DNA is not associated with histone.	DNA & histone form nucleosome or chromatin.
8) Example	Bacteria and blue green algae	Multicellular animals and plants are examples.



- \_\_\_\_\_ fibers are long, unbranched & slender.
- Inner surface of cristae contains small knob like structures called \_\_\_\_\_.
- \_\_\_\_\_ plastids are involved in storage of food.
- Nuclear membrane is \_\_\_\_\_ layered structure.
- Out of prokaryote & eukaryote, cellulose cell wall is present in \_\_\_\_\_.

Answers: (1) Microtubules (2) F1 particles (3) Leucoplast (4) double (5) Eukaryote





## VALUES

Property	Value
Resolution of human naked eye	1.0 mm
Resolution power of human naked eye	2.0 $\mu\text{m}$
Magnifying power of compound microscope	500X
Resolution power of electron microscope	2-4 $\text{\AA}$
One micron meter =	0.000,001 or $10^{-6}$
%age of proteins in cell membrane	60-80%
%age of lipids in cell membrane	20-40%
Carbohydrates in cell membrane	Small amount
Amount of water in cytosol	90%
Sedimentation rate of larger subunit of ribosome	60S
Sedimentation rate of smaller subunit of ribosome	40S
Sedimentation rate of eukaryotic ribosome	80S
Sedimentation rate of prokaryotic ribosome	70S
Size of peroxisomes	0.5 $\mu\text{m}$
Diameter of chloroplast	4-6 $\mu\text{m}$
Number of thylakoid in granum	50 or more
Number of nuclear pores in egg	30,000
Number of nuclear pores in erythrocyte	3-4
Number of chromosomes in human cell	46
Number of chromosomes in frog cell	26
Number of chromosomes in chimpanzee cell	48
Number of chromosomes in fruitfly ( <i>Drosophila</i> ) cell	8
Number of chromosomes in onion cell	16
Number of chromosomes in potato cell	48
Number of chromosomes in garden pea cell	14





## PRACTICE EXERCISE

 35 mins  
Time Yourself

- (1) **Who coined the term CELL?**
  - (a) Schwann
  - (b) Schleiden
  - (c) Robert Hook
  - (d) Both a and b.
- (2) **Who opposed the idea the cell is an empty space bounded by thick wall?**
  - (a) Lorenz Oken
  - (b) Schwann
  - (c) Robert Brown
  - (d) Rudolph Virchow
- (3) **Who first observed and thus hypothesized that new cells are formed from previously existing living cell?**
  - (a) Theodor Schwann and Schleiden
  - (b) Rudolph Virchows
  - (c) Louis Pasteur
  - (d) Both b and c.
- (4) **Resolution power of a compound microscope is**
  - (a)  $2.0 \mu\text{m}$
  - (b) 2-4 A
  - (c)  $24 \mu\text{m}$
  - (d) 24 A.
- (5) **Magnifying power of electron microscope as compared to eye is**
  - (a) 500X
  - (b) 250,000X
  - (c) 500,000 X
  - (d) 250X
- (6) **In cell fractionation various components of cells including its organelles can be isolated in different layers depending upon:**
  - (a) Their physical properties like size & weight.
  - (b) Physical properties of the medium like its density.
  - (c) Their electrical properties like their charges.
  - (d) Both a and b
- (7) **Percentage of proteins in cell membrane is**
  - (a) 20- 40 %
  - (b) 40- 50 %
  - (c) 60- 80%
  - (d) 80- 100%
- (8) **Which of the statement about cell membrane is not true?**
  - (a) It contains protein molecules embedded in lipid bilayer.
  - (b) It is a differentially permeable membrane.
  - (c) It contains charged pores, thus ions being charged particles cross cell membrane much easier than neutral particles.
  - (d) It may get infolded to engulf solid or liquid material.
- (9) **Movement of the material across the cell membrane which doesn't requiring expenditure of metabolic energy is called**
  - (a) Active transport.
  - (b) Passive transport.
  - (c) Co- transport.
  - (d) Counter transport.
- (10) **The first layer of cell wall which is formed is:**
  - (a) Primary wall.
  - (b) Secondary wall
  - (c) Middle lamella.
  - (d) All of these
- (11) **Cellulose is the major component of**
  - (a) Primary wall.
  - (b) Secondary wall
  - (c) Middle lamella.
  - (d) All of the above.



## Chapter 4

- (12) Strengthening material of prokaryotic cell wall is  
 (a) Cellulose. (b) Chitin.  
 (c) Inorganic salts, silica, waxes and lignin. (d) Peptidoglycan or Murein.
- (13) Spherical or tubular membranes which separate the material present in endoplasmic reticulum from that of cytoplasmic material are called  
 (a) Cytosol (b) Cisternae  
 (c) Polysomes (d) Cristae
- (14) Which one is not the function of endoplasmic reticulum?  
 (a) Nerve impulse conduction  
 (b) Transport of material  
 (c) Mechanical support.  
 (d) Synthesis of conjugated molecules.
- (15) Factory of ribosomal synthesis is  
 (a) Cytoplasm (b) Nucleus  
 (c) Nucleolus (d) Endoplasmic reticulum.
- (16) 60S and 40S subunit combine to form \_\_\_\_\_ particle.  
 (a) 100 S (b) 90 S  
 (c) 80 S (d) 70 S
- (17) A group of ribosomes attached to mRNA is known as  
 (a) Polymer (b) Polypeptide  
 (c) Polysome (d) Monomer
- (18) Pancreas produces secretory granules that help in digestion. These granules after passing through endoplasmic reticulum are pinched off from \_\_\_\_\_ surface of Golgi apparatus:  
 (a) Forming face (b) Maturing face  
 (c) Any of them (d) None of these.
- (19) During digesting the phagocytosed food particles, vesicles formed from fusion of phagocytic vacuole with the enzymes secreted by Golgi apparatus are called  
 (a) Lysosomes (b) Primary lysosomes  
 (c) Secondary lysosomes (d) Food vacuole.
- (20) Autophagosomes are  
 (a) Those lysosomes which eat parts of their own cells to generate energy.  
 (b) Those lysosomes which eat old and worn out cellular organelles.  
 (c) Lysosomes which help in extracellular digestion.  
 (d) Both a and b.
- (21) Cellular organelles related with  $H_2O_2$  are  
 (a) Glyoxisomes (b) Lysosomes  
 (c) Peroxisomes (d) Ribosomes.
- (22) Which of the following statement is incorrect about Glyoxisomes?  
 (a) They contain enzymes which help in conversion of fatty acids into carbohydrate.  
 (b) They are abundant in soyabeans but absent in pea.  
 (c) They are present through out life of a plant and provide them with energy through Glyoxylate cycle.  
 (d) They are single membranous organelles.





- (23) Which of the following cytoskeletal fiber contain tubulin protein?  
 (a) One which help in assembly of spindles during mitosis.  
 (b) One involved in internal cell motion.  
 (c) One involved in maintenance of cell shape.  
 (d) Both b and c.
- (24) Centrioles are composed of \_\_\_\_\_ triplets of microtubules.  
 (a) 3 (b) 9  
 (c) 10 (d) 15
- (25) The human naked eye can differentiate between two points which are \_\_\_\_\_ apart.  
 (a) 1.0 mm (b) 0.1 mm  
 (c) 1.0 cm (d) 1.0 dm
- (26) Ribonucleo-protein particles are the name of  
 (a) DNA (b) Nucleus  
 (c) Eukaryotic ribosomes (d) RNA
- (27) Ribosomes + m-RNA  
 (a) Polysome (b) Pylosome  
 (c) Polosome (d) None of these
- (28) In golgi apparatus, the maturing face is  
 (a) Biconcave (b) Convex  
 (c) Spherical (d) Concave
- (29) Proteins and lipids are converted into glycolipids and glycoproteins by adding carbohydrates by  
 (a) Ribosomes (b) Cytoplasm  
 (c) Golgi apparatus (d) Endoplasmic reticulum
- (30) Amoeboid movements and movement of cyclosis is due to  
 (a) Microfilaments (b) Microtubules  
 (c) Intermediate filaments (d) Cytoskeleton
- (31) Of the following, which one is not the characteristic of mitochondria?  
 (a) It contains  $F_1$  particles  
 (b) It is involved in the synthesis of protein  
 (c) It is a self replicating organelle  
 (d) Number of mitochondria is constant.
- (32) Chlorophyll is a/an \_\_\_\_\_ molecule  
 (a) Inorganic (b) Cationic  
 (c) Anionic (d) Organic
- (33) The part of chloroplast where  $CO_2$  is fixed to manufacture sugar is  
 (a) Stroma (b) Grana  
 (c) Thylakoid (d) Outer membrane
- (34) The type of plastids which help in pollination is  
 (a) Chromoplasts (b) Leucoplasts  
 (c) Chloroplasts (d) All of these
- (35) Ribosomes are assembled in  
 (a) Nucleolus (b) Nucleus  
 (c) DNA (d) RNA
- (36) The place of centromere where spindle fibres get attached is  
 (a) Kinetochore (b) Kinochore  
 (c) Centromere region (d) All of these



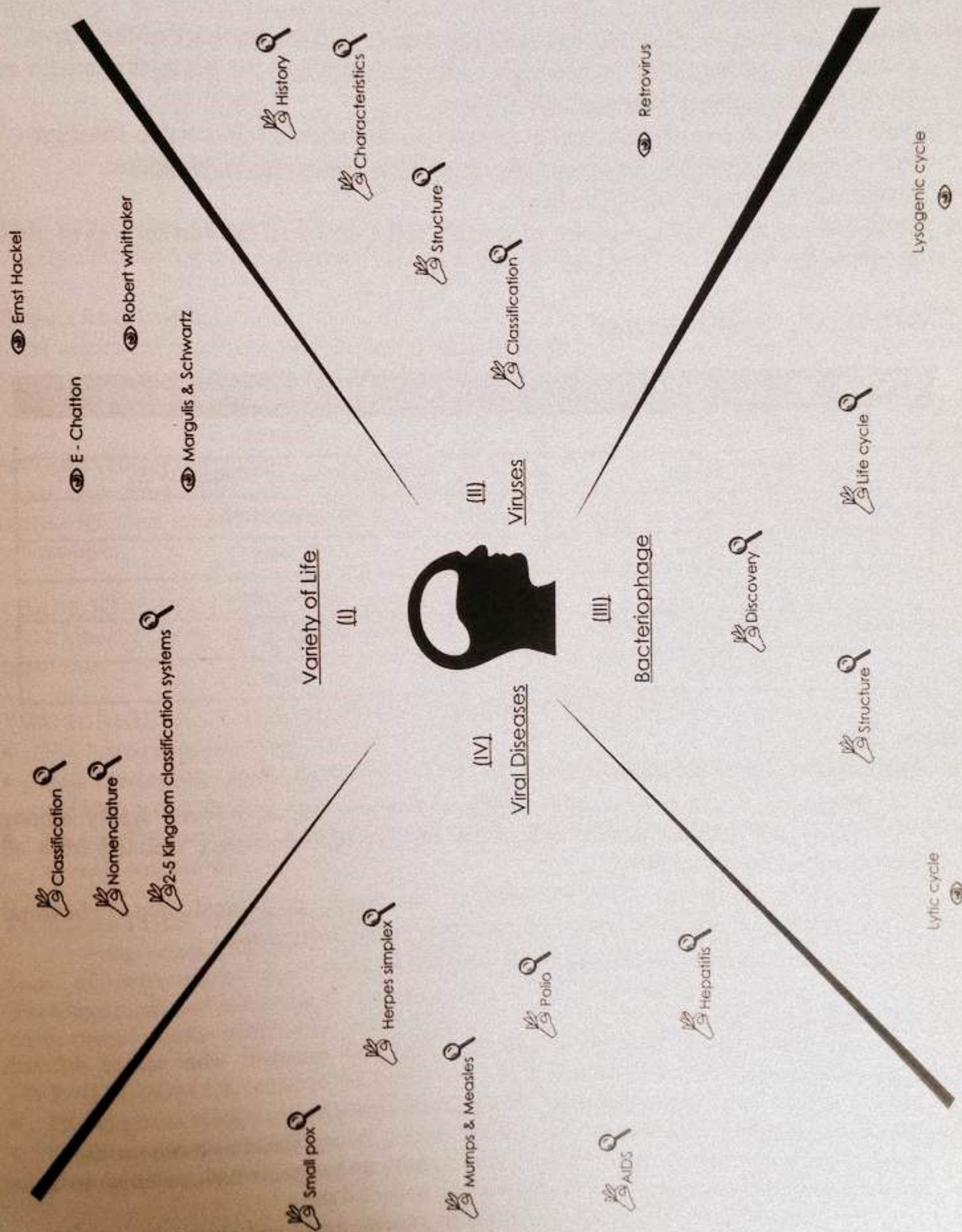


- (37) Which of the following is not present in mitochondria?  
(a) Enzymes (b) Co-enzymes  
(c) Ribosomes (d) Thylakoids
- (38) The spent energy in the form of ADP, is regenerated by mitochondria into:  
(a) AMP (b) ADP  
(c) ATP (d) All of these
- (39) Which of the following combination is an example of self replicating organelles?  
(a) Mitochondria, Ribosomes (b) Mitochondria, Nucleus  
(c) Mitochondria, Chloroplast (d) Mitochondria, Vacuole
- (40) Chlorophyll molecule contains \_\_\_\_\_ as central metal ion.  
(a)  $\text{Fe}^{2+}$  (b)  $\text{Mg}^{2+}$   
(c)  $\text{Zn}^{2+}$  (d)  $\text{Cu}^{+2}$
- (41) On which of the following component of chloroplast chlorophyll is arranged?  
(a) Cell membrane (b) Matrix  
(c) Thylakoids (d) Stroma
- (42) Which of the following impart a red colour to Rose petals?  
(a) Chloroplast (b) Chlorophyll  
(c) Chromoplast (d) Leucoplast
- (43) Number of nuclear pores /nucleus in an RBC are  
(a) 1- 3 (b) 3- 4  
(c) 10, 000 (d) 30, 000



# Chapter 5

## THE VARIETY OF LIFE





CLASSIFICATION

- "Arrangement of organisms into groups and subgroups on the basis of similarities is called classification.
- *Initially* the classification was *based* on appearance and morphology of the plants and animals, which infect does not give information about the basic similarities and the differences among different individuals.
- *Now* taxonomist classify different organisms on the basis of relationship amongst individuals, i.e., similarities in the form or structure, homologies, comparative biochemistry, cytology and genetics.
- Over one and half million species of animals and over a half million species of plants are known.

UNITS OF CLASSIFICATION

UNITS OF CLASSIFICATION	EXAMPLE (Corn = <i>Zea mays</i> )
KINGDOM	Plantae
PHYLUM	Anthrophyta (Tracheophyta)
CLASS	Angiospermae
ORDER	Poales
FAMILY	Poaceae
GENUS	<i>Zea</i>
SPECIES	<i>mays</i>

SPECIES

- Is the *basic unit* of the classification.
- "A species is a group of natural population which can *interbreed* freely among themselves and produce *fertile offsprings*, but are reproductively isolated from all other such groups in nature."
- Each specie possesses its own distinct structural, ecological and behavioral characteristics, hence species are *independent evolutionary units*.
- Different species don't exchange genes between them.

NOMENCLATURE

- *Carolous Linnaeus*, a Swedish botanist was the first scientist, who named different organisms known to him scientifically.
- First published the names of plants and then different animals.
- His system is called binomial nomenclature i.e., naming of organisms with *two words*.
- Initially different names were derived from *Latin language*, which referred to some *characteristic* of the organisms or the *person* who collected them.
- The first name refers to the genus, and is called *generic name* and always begins with the capital latter. The *species name* follows the generic name and begins with the small latter.





COMMON NAME	SCIENTIFIC NAME
Onion	<i>Allium cepa</i>
Amaltas	<i>Cassia fistula</i>
Man	<i>Homo sapiens</i>
Potato	<i>Solanum tuberosum</i>
Egg plant	<i>Solanum melongena</i>

### TWO TO FIVE KINGDOM CLASSIFICATION SYSTEM

#### TWO KINGDOM CLASSIFICATION

Initially all the living organisms were classified into two kingdoms i.e. plants and animals.

##### Plants (Autotrophs)

Those organisms which can prepare their own food from simple inorganic material and can store energy are called plants or autotrophs.

Bacteria were placed in kingdom plantae.

##### Animals (Heterotrophs)

Those organisms which can't synthesize their own food from simple inorganic material and depend for their food either on autotrophs or in decaying organic matter are called animals or heterotrophs.

#### THREE KINGDOM CLASSIFICATION SYSTEM

Third kingdom proposed by *Ernst Hackel*, protista to accommodate Euglena and bacteria like organisms.

#### TWO KINGDOM CLASSIFICATION SYSTEM BY E-CHATTON

- E- Chatton suggested these terms.
- **Pro- Cariotique:** from Greek words (Pro= before and Karyon = nucleus.) used for bacteria and blue green algae.
- **Eu- cariotique:** from Greek words (Eu = true and Karyon = nucleus) used to describe animals and plants.

#### FUNGI AS FOURTH KINGDOM

Fungi resemble plants in many respect but they are not autotrophs, infect they are special form of heterotrophs that obtain energy and structural material by breaking down (decomposition) and absorbing food substances from the surroundings, and possesses chitin as a major structural component in their cell wall.

#### FIVE KINGDOM CLASSIFICATION SYSTEM

- Five kingdom system was proposed by *Robert Whittaker*.
- Organisms were chiefly assorted in 5 groups based on their *mode of nutrition* i.e., photosynthesis, absorption, and ingestion.





## Chapter 5

Kingdom	Nutrition	Cells	Nature	Locomotion	Cell Wall	Example
Monera	Autotrophic/ Heterotrophic	Unicellular	Pro	Can move	Murein	Bacteria, Cyanobacteria
Protista	Autotrophic/ Heterotrophic	Mostly unicellular/ simple multicellular.	Eu	Can move	Mostly cellulose	Euglena, Amoeba
Plantae	Photosynthetic autotrophs	Multicellular	Eu	Can't move	Cellulose	Mosses, ferns, angiosperms
Fungi Reducers	Absorptive heterotroph	Multicellular	Eu	Can't move	Chitin	Penicillium, mushrooms
Animalia	Ingestive heterotroph	Multicellular	Eu	Can move	No	Birds, reptiles

## MODIFIED FIVE KINGDOM SYSTEM

- Five kingdom system was modified by *Lynn Margulis* and *Karlene Schwartz*, by considering cellular organization, mode of nutrition, cytology, genetics and organelles of symbiotic origin (mitochondria, chloroplast, flagella)
- Five kingdom proposed by them are as follows:
  1. Prokaryotae (Monera)
  2. Protocista (Protists)
  3. Plantae
  4. Animalia
  5. Fungi.



1. A family contains related \_\_\_\_\_.
2. Linnaeus took the scientific names from \_\_\_\_\_ word.
3. *Solanum melangena* is the scientific name for \_\_\_\_\_.
4. In 1866, \_\_\_\_\_ proposed a third kingdom protista.
5. The eukaryotic multicellular consumers are placed in kingdom \_\_\_\_\_.

VIRUSES

- The word virus is derived from *Latin word venome* meaning poisonous fluid.
- "Non cellular infectious entities which contain either RNA or DNA, normally incased in a proteinaceous coat, reproducing only in living cells are called viruses"
- Previously they were generally referred to a poison associated with disease and death.
- Prions are infectious proteins which are responsible for mad cow infection and mysterious brain infection.

Answers: (1) Genus (2) Latin (3) Brinjal (4) Ernst Haeckel (5) Animalia



SCIENTIST	ACHIEVEMENT IN DISCOVERY OF VIRUSES
Edward Jenner	Discovery of vaccine, from material isolated from cowpox lesion.
Louis Pasteur	Word 'vaccination', from Latin word, "vacca" meaning cow. Since the initial Jenner's work was on cowpox lesions.
Charles Chamberland	The agent causing Rabies can't be filtered, thus this unseen filterable agent was described as a virus.
Ivanowski	Tobacco mosaic virus can't be filtered and showed that healthy tobacco leaves get infected when exposed to bacteria free filtrate from group of infected plants.
Stanely	Purified and crystallized the tobacco mosaic viruses.
Twort	Discovery of bacteriophage by experimenting on bacteria which got lysed but survived on heating the filtrate.
D'Herelle	Rediscovery of Twort's observations and named these agents as bacteriophages meaning "bacteria eater".

### CHARACTERISTICS OF VIRUSES

#### Size

- Can only be seen by *electron microscope*.
- Range from *250 nm* of *poxviruses* to *20 nm* of *parvovirus*.
- *10 – 1000 times smaller* than most bacteria.

#### Shape

- *Animal and plant viruses* are polyhedral (having many sides), helical (spiral), enveloped or complex.
- *Bacteriophages* occur in helical or cubical symmetry. Cubical are regular solids or icosahedral (having 20 faces) and helical phages are rod shaped. A phage may have a head which is polyhedral and a tail, which is rod shaped.

#### Growth

Can't grow in artificial media.

#### Reproduction

They are *obligate intracellular parasites* thus can only reproduce in animal or plant cell or in microorganism. They reproduce by *replication* (a process by which many copies or replica of viruses are formed).

#### Synthesis of Nucleic Acid And Proteins

Since they lack metabolic machinery for the synthesis of their own nucleic acid and proteins thus depend on the host cell to carry out these functions.



**Resistance**

All viruses are generally resistant to broad range of available antibiotics such as penicillin, streptomycin and others.

**STRUCTURE OF VIUSES**

- A complete, mature and infectious particle is known as *virion*.

- A virion is composed of:

**Central core** of nucleic acid, either DNA or RNA, also known as the genome.

**Capsid**, a surrounding protein coat. It

- Gives definite shape to the virus.
- Made up of protein subunits called *capsomeres*, the number of which is particular for each virus, e.g., 162 capsomeres are in capsid of *herpes virus* and 252 in the *adenovirus*

**The envelope** is an outer covering structure present in some of the animal viruses. Non enveloped viruses are called *naked viruses*.

**LIFE CYCLE OF BACTERIOPHAGE**

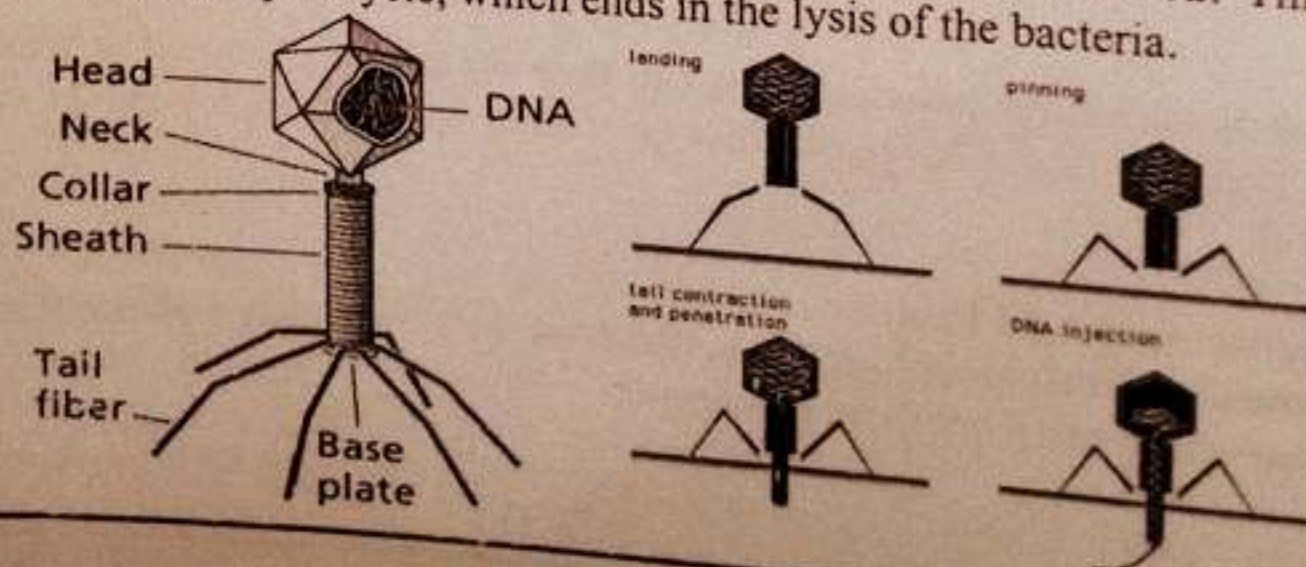
So far the best studied phage virus is that which infect E. coli, and is called T phage (t for type), and among them T<sub>2</sub> and T<sub>4</sub> phages mainly used in phage studies.

**STRUCTURE OF T4**

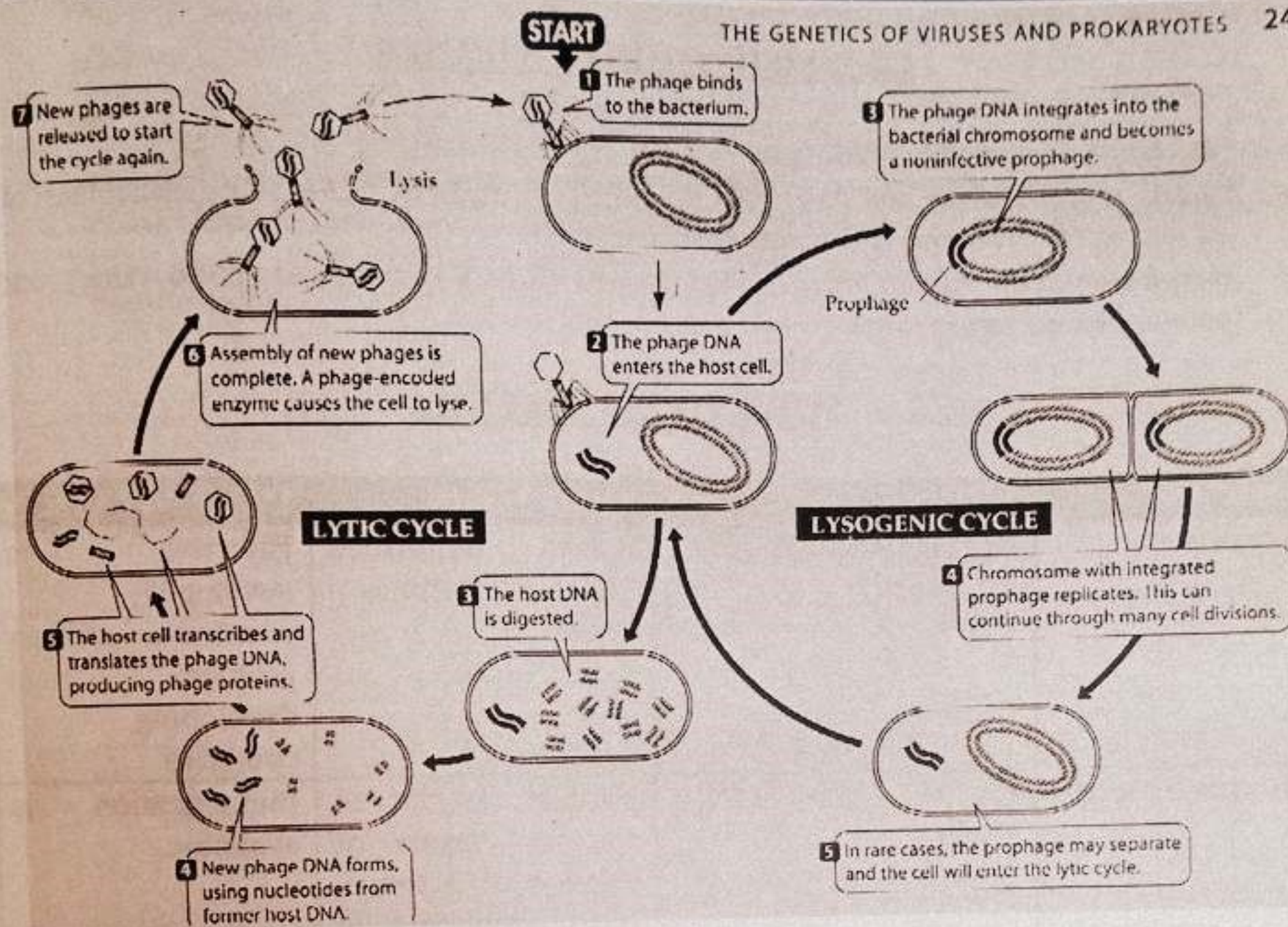
- T<sub>4</sub> resembles a *tadpole*, with a head and a tail.
- Its **head** is an elongated pyramidal, hexagonal, prism shaped structure, containing DNA and to which straight tail is attached.
- **Tail** is more complex than head, consisting of an inner proteinaceous core, enclosed in a sheath, made of another protein, to one end of which there is **collar** and to the other **end plate**. **Six tail fibers** meant for attachment are attached with the tail.
- Its volume is  $1/1000$  of its host i.e., E.Coli.

**STEPS OF LIFE CYCLE**

- It replicates only inside the bacterial cell.
- First step is the attachment (adsorption).
- Next step is penetration, the tail releases the enzyme lysozyme to dissolve a portion of bacterial cell wall.
- Third step is injection of viral DNA in bacterial cell.
- Then two types of cycles are usually seen i.e. lytic and lysogenic cycle.
- Induction involves either a *spontaneous or environmentally induced*. This results in the initiation of a typical lytic cycle, which ends in the lysis of the bacteria.







Feature	Lytic Cycle	Lysogenic Cycle
Virus involved	Lytic or virulent phage	Lysogenic or temperate phage
Relationship	Master – Slave relation	Host – Guest relation
Effects	Infectious cycle	Non-infectious cycle



- The branch which deals with the study of viruses is called \_\_\_\_\_.
- Viruses reproduce by \_\_\_\_\_.
- Non-enveloped viruses are known as \_\_\_\_\_ virions.
- T4 resembles that of \_\_\_\_\_.
- Induction converts \_\_\_\_\_ phage into \_\_\_\_\_ phage.
- T4 infects \_\_\_\_\_ bacterium.

Answers: (1) Virology (2) Replication (3) Naked (4) Tadpole (5) Lysogenic, Lytic (6) E. Coli





### CLASSIFICATION OF VIRUSES

Viruses can be classified according to

- **Nucleic acid properties** and their type: e.g., viruses with DNA, RNA as a genetic material, and wit naked, enveloped or complex nucleic acid.
- **Morphologically** viruses may be rod shaped (T.M.V), spherical (polio virus), and tadpole like bacteriophages.

### SOME VIRALL DISEASES

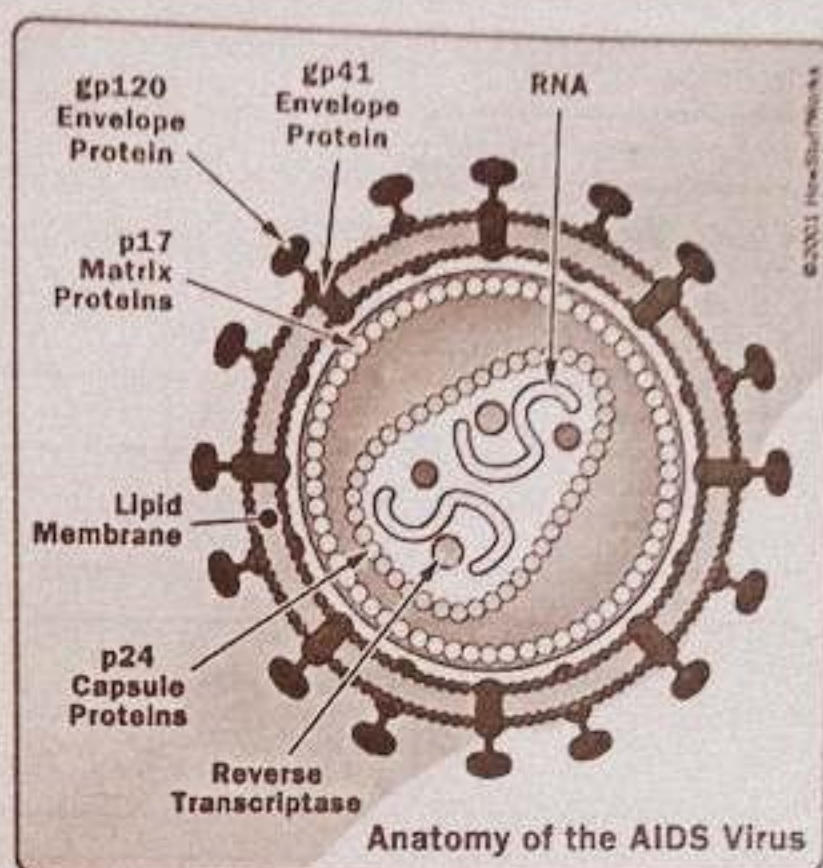
DISEASE	VIRUS	SYMPTOMS	IMMUNIZATION
Small pox	Pox virus (DNA enveloped)	Raised fluid-filled vesicles > Pustules > Pocks	Effective in developed countries, still a problem in developing countries.
Herpes Simplex	Herpes virus (DNA virus)	Vascular lesions in epithelial layers of ectodermal tissue. Most commonly in mouth, lips, and skin.	Immunization is available.
Influenza	Influenza virus (RNA virus)	Running nose, headache, fever	Immunization is available.
Mumps & Measles	Paramyxovirus (enveloped RNA virus)	Skin diseases, contagious but seldom fatal, equally in childhood and adults.	Disease develops immunity in its victim. 60% of adults are immune to it.
Polio	Polio virus (RNA virus, in spherical capsid). Smallest known virus	Paralysis	Immunization available, effective immunization in Pakistan results in effective control.

### RETROVIRUS (ONCOVIRISES)

- Retroviruses are *associated with* tumor production in animals like fowl, rodents and cats.
- Human immunodeficiency virus (**HIV**) which causes acquired immunodeficiency syndrome (AIDS) is a retrovirus.



- They are *spherical*, 100nm in diameter, *enveloped* by host plasma membrane, contains single stranded RNA.
- May be *non-specific* in their action but usually infect those cells containing specific receptors e.g., in HIV infect *CD4* + human W.B.C. (helper T- lymphocytes)
- *Reverse transcriptase* is a special enzyme which can convert single stranded RNA into double stranded viral DNA, which not only infect the host cell but also incorporate in to host genome as a provirus that can pass on to progeny cells. In this way normal cells become cancer cells.



### ACQUIRED IMMUNO DEFICIENCY SYNDROME (AIDS)

- Acquired immunodeficiency syndrome (AIDS) *first reported* in young homosexual males, having one or more complex symptoms like severe pneumonia, vascular tumor, sudden weight loss, swollen lymph nodes and immune deficiency.
- AIDS is caused by *HIV* a retrovirus, which is *host specific*, since it infects and multiplies in monkeys but does not cause disease.

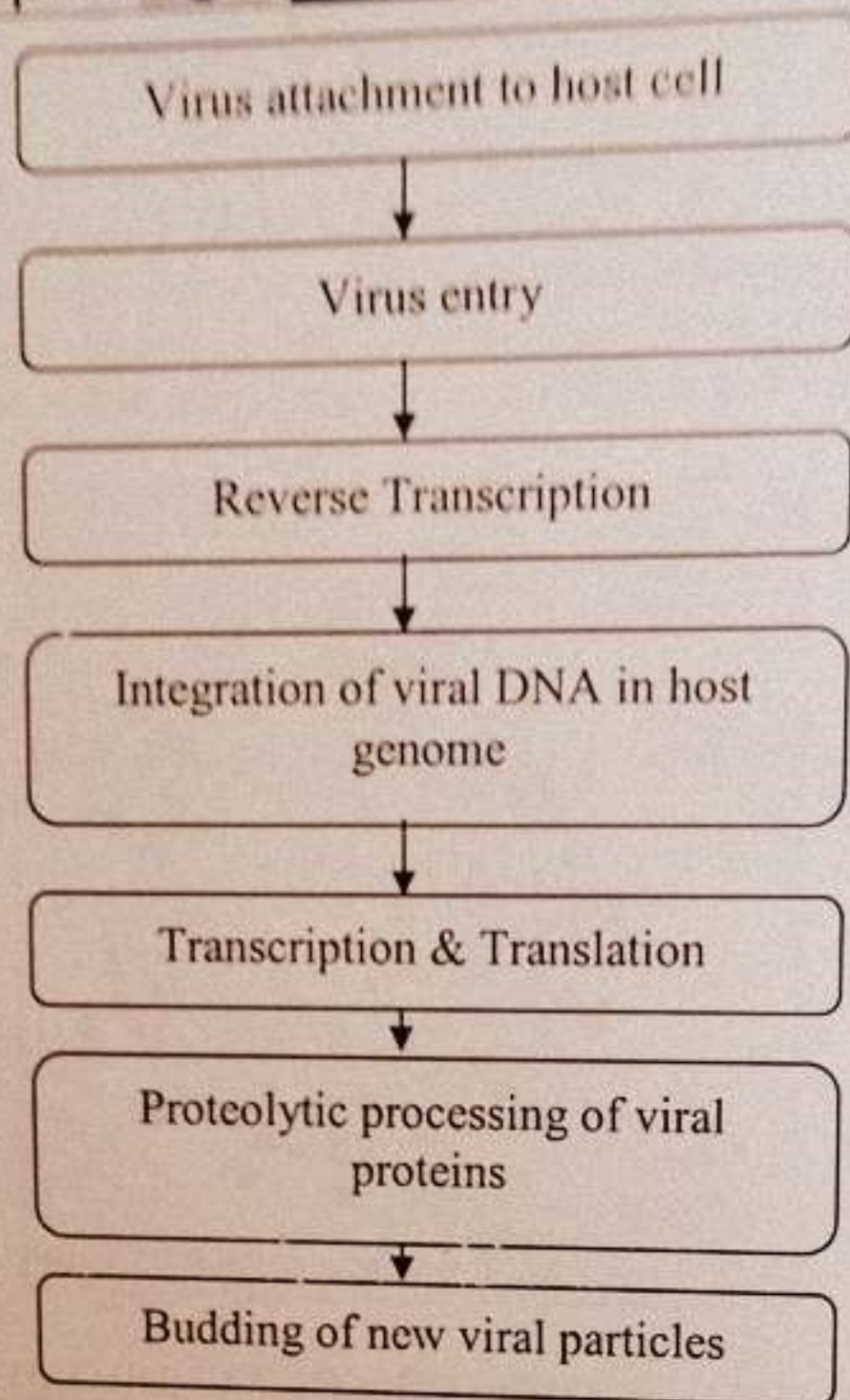
#### **Mode Of Transmission**

- By intimate *sexual contact* (virus present in body secretions and blood, which gets entry in recipient blood from minor wear and tears, more common in homosexuals).
- Contact with blood and blood products (infected *blood transfusion*).
- *Brest feeding*
- *Prick* of an infected needles (problem for health care providers).
- HIV also infects cells of *C.N.S.*

#### **Prevention**

- Avoid sharing syringes, use sterile needles, syringes and utensils.
- Avoid prohibited sexual contacts especially homosexuality.
- Screen the blood and blood products before transfusion.
- Vaccine has been synthesized and administered on experimental basis.





### HEPATITIS

- It is an *inflammation of liver*.
- It is *caused by* viral infection (Hepatitis virus), toxic agents or drugs.
- Disease may be in acute or in chronic form.
- *Acute form* is characterized by non specific symptoms like, fatigue, distaste to cigarettes, abdominal pain, fever leading to specific symptoms like Jaundice and liver enlargement.
- A *chronic form* is mostly silent eventually leading to chronic Liver disease a fatal disease which may progress to liver cancer and even death.

Hepatitis	Virus	Common name	Source of transmission
A	HAV (RNA non-enveloped)	Infectious hepatitis	Feces
B	DNA virus	Serum hepatitis	Serum
C	RNA enveloped	Infusion	Blood
D	Delta virus	Delta	
E	RNA non-enveloped	-	Feces
F & G		Unidentified	



## Prevention

- Good hygienic food and water.
- Screening the blood.
- Avoiding needle prick.
- Avoiding prohibited sex.



1. Morphologically polio virus is \_\_\_\_\_.
2. Small pox virus is \_\_\_\_\_ enveloped virus.
3. Retroviruses are \_\_\_\_\_ in diameter.
4. Reverse transcription of HIV occurs in \_\_\_\_\_ of WBC.
5. Outer most part of HIV is \_\_\_\_\_.
6. \_\_\_\_\_ is an inflammation of liver.
7. Delta hepatitis is another name used for \_\_\_\_\_.

## VALUES

Property	Value
Range of size of viruses	20 nm – 250 nm
Smallest viruses (Parvoviruses)	20 nm
Largest viruses (Poxviruses)	250 nm
Viruses smaller than bacteria	10-1000 times
Number of capsomeres in Herpes virus	162
Number of capsomeres in Adenovirus	252
During lytic cycle after 25 minutes number produced	200
Adults immune to measles	60%

Answers: (1) Spherical (2) DNA (3) 100 nm (4) Cytoplasm (5) Envelop (6) Hepatitis (7) Hepatitis D



## PRACTICE EXERCISE

35 min  
Time Yourself

- So far over \_\_\_\_\_ number of species of animals are known:  
(a) 1/2 million (b) 1 million  
(c) 1 1/2 million (d) 2 million.
- Which of the following category is most general, with its members least resembling with each other than the other categories:  
(a) Species (b) Genus  
(c) Family (d) Order
- Solanum tuberosum* is a scientific name of :  
(a) Onion (b) Amaltas  
(c) Potato (d) Tomato
- Allium cepa* is the scientific name of :  
(a) Onion (b) Amaltas  
(c) Potato (d) Tomato
- Those organisms which can prepare their own food from simple inorganic material and can store energy are called  
(a) Autotrophs (b) Heterotrophs  
(c) Pro- cariotique (d) Eu- cariotique
- Which of the Euglena's (a Protoctista) character resembles that of animals:  
(a) They can move (b) They lack cell wall.  
(c) They don't have chlorophyll. (d) Both A and B
- The word which E- Chatton suggested for bacteria and blue green algae was:  
(a) Autotrophs (b) Heterotrophs  
(c) Pro- cariotique (d) Eu- cariotique
- Organisms of which of the following kingdom have absorptive mode of nutrition:  
(a) Prokaryotae (b) Protoctista  
(c) Animalia (d) Fungi.
- Which of the following organisms have Chitin as a major structural component of their cell wall:  
(a) Prokaryotae (b) Protoctista  
(c) Plantae (d) Fungi
- Five kingdom classification was proposed by:  
(a) Carlous Linnaeus (b) E- Chatton  
(c) Robert Whittaker (d) Lynn Margulis and Karlene Schwartz
- Amoeba belongs to which kingdom:  
(a) Prokaryotae (b) Plantae  
(c) Monera (d) Protista
- Kingdom Protoctista includes:  
(a) Prokaryotic organisms. (b) Unicellular organisms  
(c) Fungi (d) Eu- cariotique organisms.
- Other name for Kingdom monera is:  
(a) Protoctista (b) Prokaryotae  
(c) Archae (d) None of these





14. The word virus is derived from Latin word **venome** meaning
  - (a) Sweet fluid
  - (b) Sore Fluid
  - (c) Poisonous Fluid
  - (d) Salty Fluid
15. DNA or RNA of viruses is enclosed in \_\_\_\_\_ coat:
  - (a) Protein
  - (b) Carbohydrate
  - (c) Lipid
  - (d) DNA.
16. Vaccine Was discovered by:
  - (a) Louis Pasteur
  - (b) Edward Jennar
  - (c) Ivanowski
  - (d) Stanely
17. The name Bacteriophage was coined by:
  - (a) Charles Chamberland
  - (b) Ivanowski
  - (c) Twort
  - (d) D'Herelle
18. The size of smallest virus is:
  - (a) 10 nm
  - (b) 20 nm
  - (c) 30 nm
  - (d) 40 nm
19. The size of poxvirus is:
  - (a) 20 nm
  - (b) 200 nm
  - (c) 250 nm
  - (d) 300 nm
20. Viruses are \_\_\_\_\_ smaller than bacteria
  - (a) 10- 100 times
  - (b) 10- 1000 times
  - (c) 100- 1000 times
  - (d) 1000- 100,00 times
21. Which of the statement about viruses is incorrect:
  - (a) We can't grow them in laboratories on artificial medias
  - (b) They are obligate intracellular parasite.
  - (c) They can synthesize their nucleic acid.
  - (d) They are resistant to most of antibiotic treatment.
22. Protein subunits of capsid is called the capsomeres, is a characteristic of each virus. Their number in Herpes virus is:
  - (a) 100
  - (b) 152
  - (c) 162
  - (d) 172
23. Protein coat, the capsid of adenovirus is:
  - (a) Surrounded by genome.
  - (b) Surrounding genome.
  - (c) Surrounding the envelope.
  - (d) Both B and C
24. The agent of controversial nature causing mad cow infection is:
  - (a) Bacteria
  - (b) Cowpox Virus
  - (c) Adenovirus
  - (d) Prion
25. A virion is:
  - (a) Virus
  - (b) Viral protein
  - (c) Viral lysozyme
  - (d) Viral gene.
26. An isolated virus is not considered living since it:
  - (a) Separates in to two inner parts.
  - (b) Can't metabolize
  - (c) Rapidly loses its Genome chemical inert
  - (d) Is coated with an air tight shield.
27. Bacteriophage that infect E. coli are called:
  - (a) M type
  - (b) N type.
  - (c) T type
  - (d) S type.

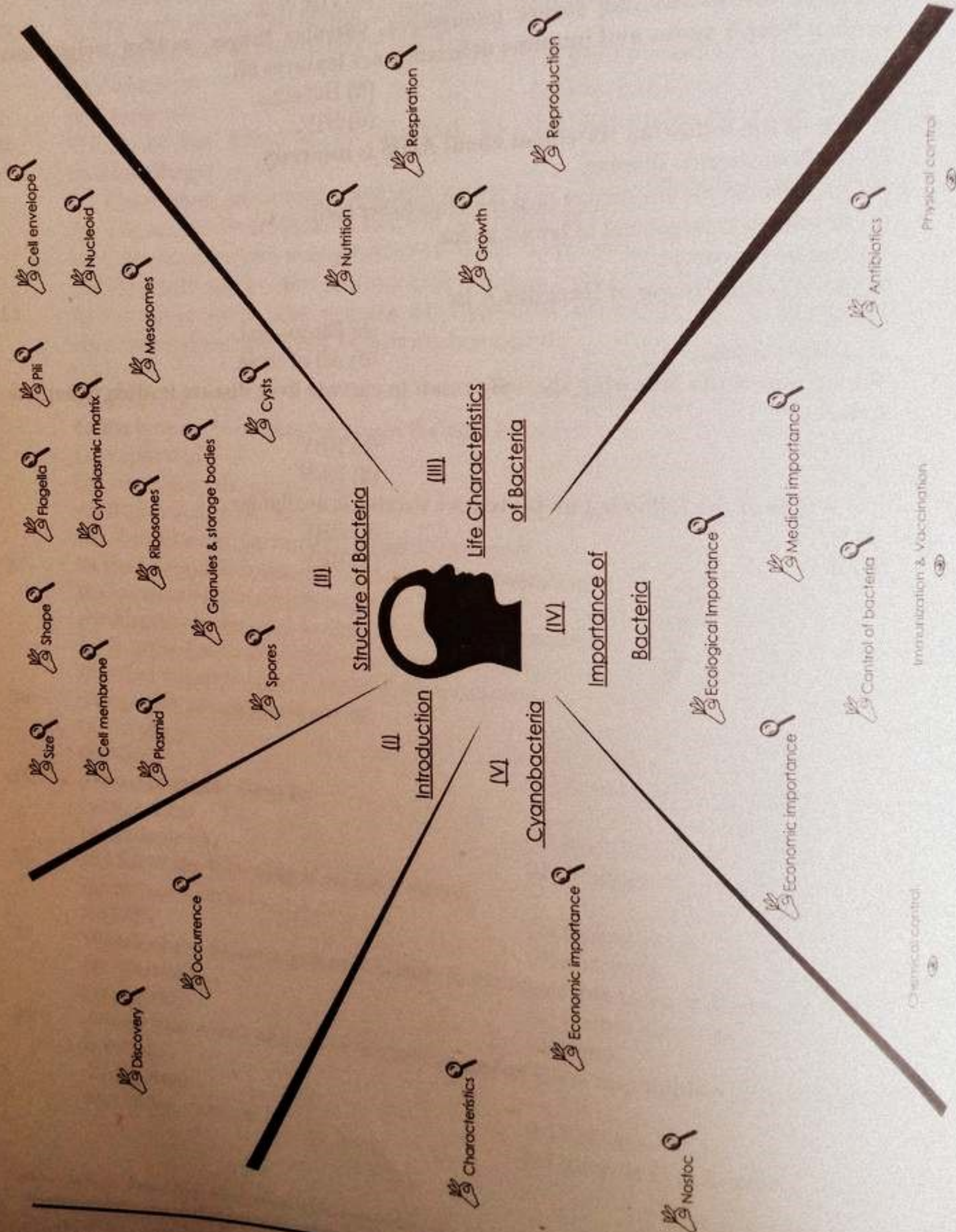


28. Attachment of the bacteriophage with the receptor site on the bacterial cell wall involves:
- Strong covalent bond between virion and the receptor site.
  - Weak chemical union between them.
  - Both A and B depending upon the phage.
  - None of these
29. In life cycle of bacteriophage, which step occurs after attachment of prophage with the receptor site of the bacterial cell wall:
- Absorption.
  - Multiplication.
  - Lysogeny.
  - Penetration
30. Which of the following is incorrect for the lysogenic cycle in life cycle of bacteriophage:
- Phage when gets incorporated with the bacterial chromosome is called prophage.
  - The bacterium continues to live and reproduce normally.
  - Lysogenic bacteria may get infected by the related phage.
  - The cycle may convert into lytic type resulting from environmental exposure.
31. In lysogenic cycle, the process of separation of phage DNA from the host's chromosome and initiation of lytic cycle is called:
- Lysis
  - Lysogeny
  - Induction
  - Adsorption.
32. In the lytic cycle of bacteriophage the host DNA is:
- Replicated
  - Turn off by the protein coat.
  - Digested into its nucleotides
  - Turned on by the removal of the protein coat.
33. In the Lysogenic cycle, the DNA of the bacteriophage:
- Joins the bacterial chromosomes.
  - Attaches to the inner surface of the host membrane.
  - Is immediately degraded when enters the host.
  - Goes directly to host ribosomes for translation.
34. Temperate phage may exist as:
- Prophage
  - Capsid.
  - Viron
  - Retrovirus.
35. Tobacco mosaic virus is:
- Spherical
  - Rod shaped
  - Tadpole like
  - Hexagonal.
36. Which of the following is an RNA virus:
- Influenza virus
  - Herpes virus
  - HBV.
  - Pox virus
37. Which of the following disease results in Paralysis due to viral attack on C.N.S:
- Measles
  - Herpes simplex.
  - Hepatitis
  - Polio
38. An enzyme which can convert single stranded RNA into double stranded viral DNA is called:
- DNAase
  - RNAase.
  - DNA polymrase.
  - Reverse Transcriptase



39. Which of the following virus has special affiliations with the tumor production:  
(a) Hepatitis virus. (b) Retrovirus.  
(c) Polio virus. (d) Pox virus.
40. Which of the following is the smallest known virus:  
(a) Hepatitis virus. (b) Retrovirus.  
(c) Polio virus. (d) Pox virus.
41. Complex symptoms like severe pneumonia, vascular tumor, sudden weight loss, swollen lymph nodes and immune deficiency are features of:  
(a) Polio. (b) Hepatitis.  
(c) AIDS. (d) HIV.
42. Which of the following statement about AIDS is incorrect:  
(a) is a host specific disease.  
(b) An infected mother cannot pass the virus to her baby.  
(c) Results in enlargement of lymph nodes.  
(d) Can be prevented.
43. Mode of transmission of Hepatitis A is:  
(a) Serum. (b) Faeco- oral.  
(c) Sexual contact (d) All of these.
44. Which one of the following specially result in chronic liver disease leading to hepatic failure:  
(a) HAV (b) HBV  
(c) HCV (d) HEV
45. For which of the following no preventive vaccine is available.  
(a) HAV (b) HBV  
(c) HCV (d) HEV







- Kingdom Prokaryotae consists of organisms with prokaryotic cells.
- 'Pro' means 'before' and 'karyon' means 'nucleus'.
- Microbiologists place bacteria in two major categories *eubacteria* (Greek for "true bacteria") and a much smaller division *archaeobacteria* (Greek for "ancient bacteria").

### DISCOVERY OF BACTERIA

SCIENTIST	ACHIEVEMENTS
A.V. Leeuwenhoek	Discovered bacteria & protozoa by simple microscope and named them as animalcules.
Louis Pasteur	<ul style="list-style-type: none"> <li>• Development of vaccines for Anthrax, Fowl Cholera, Rabies.</li> <li>• Pasteurization.</li> <li>• Fermentation</li> <li>• Proved experimentally that microbes could cause disease.</li> </ul>
Robert Koch	<ul style="list-style-type: none"> <li>• Discovered causative agents of anthrax from blood of sheep, a rod shaped bacterium.</li> <li>• Discovered bacteria that cause tuberculosis.</li> <li>• Developed techniques of inoculation.</li> <li>• Isolation, media preparation, maintenance of pure culture, preparation of specimen.</li> <li>• Formulated germ theory of disease.</li> </ul>

- 1) A specific organism can always be found in association with a given disease.
- 2) The organism can be isolated and grown in pure culture in the laboratories.
- 3) The pure culture will produce the disease when inoculated into susceptible animal.
- 4) It is possible to recover the organism in pure culture from the experimentally infected animals.

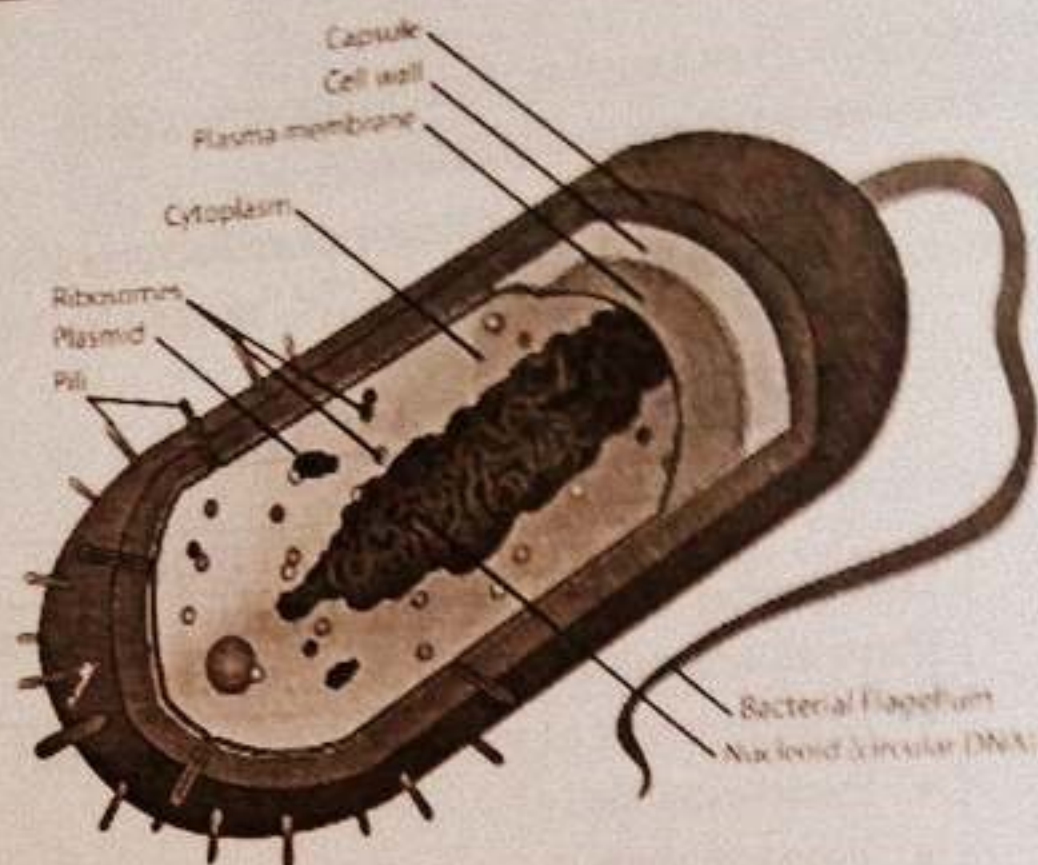
### OCCURANCE OF BACTERIA

- Bacteria are **universal** in occurrence.
- Their **number** varies according to locality and environment.
- Some always contribute to **natural flora**.
- Other live in **specific** environmental conditions e.g., high temp, alkaline or acidic conditions.

### STRUCTURE OF BACTERIA

- All bacteria cell invariably have a cell membrane, cytoplasm, ribosomes and chromatin bodies.
- The majority have **cell wall**, which gives shape to the bacterial cell.
- **Specific structures** like capsule, slime, flagella, pili, fimbriae and granules are not found in all bacteria.





### SIZE OF BACTERIA

TYPE	SIZE
Range	0.1-600 $\mu\text{m}$
Mycoplasma (smallest)	100-200 nm
Escherichia coli	1.1-1.5 $\mu\text{m}$ (width), 2.0-6.0 $\mu\text{m}$ (length)
Spirochete	500 $\mu\text{m}$
Staphylococci & Streptococci	0.75-1.25 $\mu\text{m}$
<i>Epulopiscium fishelsoni</i>	600 $\mu\text{m}$ x 80 $\mu\text{m}$

### SHAPES OF BACTERIA

- Bacteria may be **Cocci** (Spherical or oval in shape), **Bacilli** (Rod shaped) and **Spiral** (Curved or spring shaped).
- Some have characteristic shapes; others are **pleomorphic** (variable shape).

TYPE	SHAPE	DIVISION
Coccus	Spherical	
Diplococcus	Two cocci	No
Streptococcus	Cocci in chain	Single plane of division
Staphylococcus	Irregular arrangement	Single plane of division
Tetrad	Group of four	Random planes
Sarcina	Group of eight	Two planes of division
Bacillus	Rod shaped	Three planes of division
Diplobacillus	Two bacilli	No
Streptobacillus	Chain of bacilli	Single plane of division
Spirals	Spirally coiled	Single plane of division
Vibrio	Comma shaped	No
Spirillum	Thick, rigid spiral	No
Spirochete	Thin, flexible spiral	No



FLAGELLA

- *Flagella* are extremely thin hair like structures.
- They come out through cell wall and originate from *basal bodies*, structures just beneath the cell membrane in the cytoplasm.
- It is made up of protein "*Flagellin*".
- *Cocci* very rarely have flagella.
- They help in *locomotion*.
- With the help of flagella, flagellated bacteria can also detect and move in response to chemical signals which is a type of behaviour called as "*Chemotaxis*".

## Classification On Base Of Flagella

TYPE	FLAGELLA
Atrichous	No flagella
Monotrichous	Single flagellum at one end
Lophotrichous	Tuft of flagella at one pole
Amphitrichous	Tuft of flagella at both poles
Peritrichous	Bacterium equally surrounded by flagella

PILI

- These are *hollow, non-helical* filamentous appendages.
- They are *smaller than flagella*.
- True pili are *only present in gram-negative bacteria*.
- They are *not* involved in *locomotion*.
- Pili are primarily involved in a mating process between cells called "*Conjugation process*".
- Some pili function as a *mean of attachment* of bacteria to various surfaces.

CELL ENVELOPE

Complexes of layers external to the cell protoplasm are collectively called cell envelope and include capsule, slime and cell wall.

## Capsule

- A *thick, gummy* structure giving sticky character to colonies of encapsulated bacteria.
- It is made up of *polysaccharide* units or *proteins* or both.

## Slime

- *Loose soluble* shield of macromolecules.
- Slime provides greater *pathogenicity* to bacteria.
- It protects them from *phagocytosis*.

## Cell Wall

- A rigid structure between extracellular substances and cytoplasmic membrane.
- Cell wall is only *absent in Mycoplasma*.
- It is composed of a macromolecule called *peptidoglycan* consisting of long glycan chains cross linked with peptide fragments.





- *Sugar, teichoic acid, lipoproteins and lipopolysaccharides* are also present which are linked with peptidoglycans.
- Cell wall of *archaeobacterial* does not contain peptidoglycan, rather contain proteins, glycoproteins and polysaccharides.
- It determines the *shape of bacteria*.
- It *protects* the cell *from osmotic lysis*.
- It provides *identity to different bacteria*, depending upon their staining characteristics i.e., Gram positive and Gram negative bacteria.

CHARACTERISTICS	GRAM-POSITIVE	GRAM-NEGATIVE
Staining character	Purple.	Pink.
Number of major layers	1	2
Chemical make up	Peptidoglycan (50% of dry weight in some bacterial cells), teichoic acid and lipoteichoic acid, lipids (1-4%)	Lipopolysaccharides, lipoproteins, peptidoglycan (10% dry weight of some bacterial cells), lipids (11-12%)
Overall thickness	20-80 nm	8-11 nm
Outer membrane	No	Yes
Periplasmic space	Present in some	Present in all
Permeability	More permeable	Less permeable

### CELL MEMBRANE

- It is thin, flexible structure beneath the cell wall, surrounding cytoplasm.
- Bacterial membrane differs from eukaryotic membrane is *lacking sterols* such as cholesterol.
- It is involved in *transport* of proteins, nutrients, sugar and electron or other metabolites.
- The plasma membrane of bacteria also contains *enzymes for respiratory metabolism* i.e. site for cellular respiration.

### CYTOPLASMIC MATRIX

- A *gel like* substance present between the plasma membrane and the nucleoid.
- Plasma membrane and everything present within it is called *protoplast*.
- Bacterial matrix lack membrane bounded organelles & cytoskeleton however chromatin, nuclear body, ribosomes, mesosomes, granules and nucleoid are present in it.

### NUCLEOID

- Bacteria like other prokaryotic cells lack definite membrane bounded nucleus and chromosomes.
- Nucleoid is a single, circular, double stranded DNA molecule, aggregates as an irregular shaped dense area in the centre of bacterial cell
- Extremely long molecule of DNA that is tightly folded to fit inside the cell component is chromatin body.
- Bacteria have a single chromosome, thus they are *haploid*.



PLASMID

- Circular, double stranded DNA molecules, *self-replicating* but not essential for the bacterial growth and metabolism
- Contain genes of *drug and insect resistance*.
- Plasmids are important vectors in modern genetic engineering techniques.

RIBOSOMES

- They are composed of *RNA and proteins*.
- May be loosely attached to the cell membrane.
- *Smaller* than eukaryotic ribosome.

MESOSOMES

- They are formed by *invagination of cell membrane*.
- They are involved in DNA replication, cell division, export of exocellular enzymes and also contain respiratory enzymes.

STORAGE BODIES

- Store *extra nutrients* like glycogen, sulphur, fat and phosphate.
- Also store *waste material* like alcohol, lactic acid, and acetic acid.

SPORES

- These are *metabolically dormant* bodies, resistant to adverse physical environmental conditions.
- They may be *exospore* (external to vegetative cell) or *endospore* (inside vegetative cell).
- They *germinate* to form vegetative cell under favorable condition.
- They normally develop at *end stage of growth* of bacteria.

CYSTS

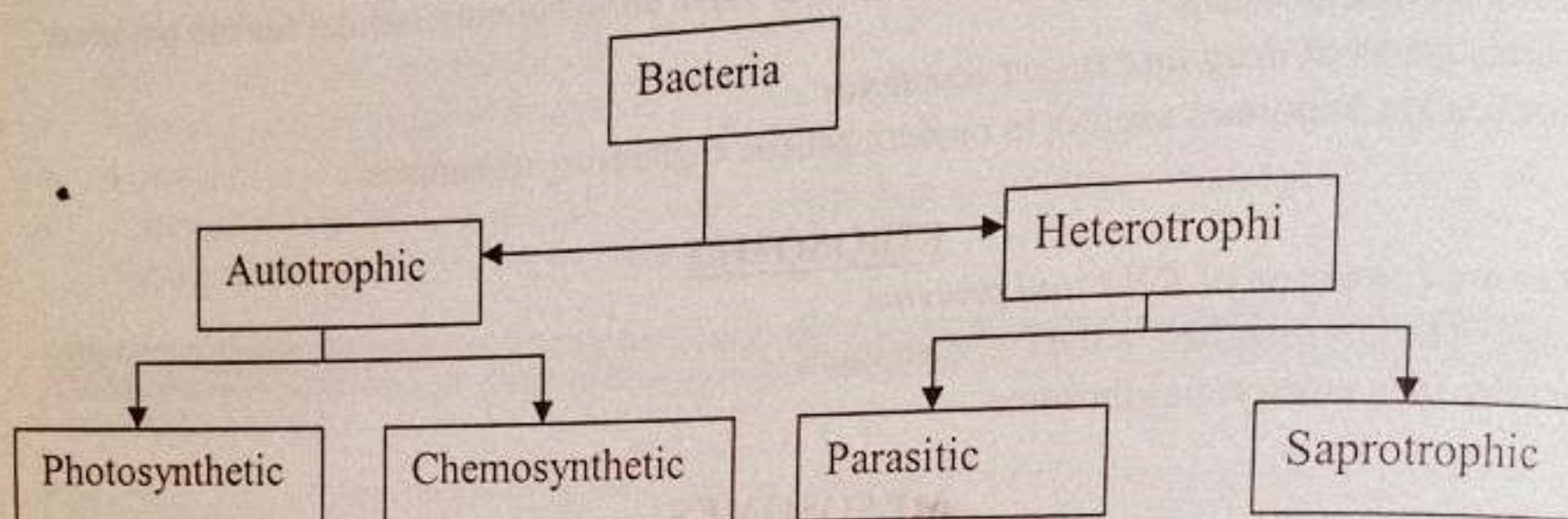
- They are *dormant, thick walled* desiccation resistant but not heat resistant structures.
- They develop during *differentiation of vegetative cells* which can germinate under suitable conditions.



1. Causative agent of anthrax was first discovered by \_\_\_\_\_.
2. Thin and flexible spirals are \_\_\_\_\_.
3. \_\_\_\_\_ are extremely thin hair like appendages in bacteria.
4. \_\_\_\_\_ are hollow, non-filamentous appendages.
5. Outer membrane is not present in gram \_\_\_\_\_ bacteria.
6. Bacteria have a single chromosome, thus they are \_\_\_\_\_.
7. \_\_\_\_\_ normally develop at end stage of growth of bacteria.

Answers: (1) Robert Koch (2) Spirochete (3) Flagella (4) Pili (5) Positive (6) Haploid (7) Spore



NUTRITION OF BACTERIA

- Those bacteria which cannot synthesize their organic compounds from simple inorganic substances are called *heterotrophic bacteria*.
- Saprophytic bacteria* get their food from dead organic matter present in soil in the form of humus (material from partial decay of plants and animals).
- Saprotrophic bacteria have an *extensive enzyme system* that break down the complex substances of humus to simple compounds.
- Those bacteria which are fully dependent upon their host for nutrition are *parasitic bacteria*.
- Those bacteria which can synthesize their organic compounds from simple inorganic substances are called *autotrophic bacteria*.
- Photosynthetic bacteria* carry out photosynthesis, as they contain chlorophyll dispersed in cytoplasm and thus is different from that of present in cells of green plants.
- Examples* of photosynthetic bacteria are green sulphur bacteria, purple sulphur bacteria, purple non-sulphur bacteria etc.
- Chemosynthetic bacteria* oxidize inorganic compounds like ammonia, nitrates, nitrites, sulphur or ferrous ions and trap the energy thus released for their synthetic reactions e.g. nitrifying bacteria.

RESPIRATION IN BACTERIA

TYPE	REQUIREMENT	EXAMPLE
Aerobic bacteria	Presence of Oxygen	<i>Pseudomonas</i>
Anaerobic bacteria	Absence of oxygen	<i>Spirochete</i>
Facultative bacteria	Either presence or absence of oxygen	<i>E. Coli</i>
Microaerophilic	Low concentration of O <sub>2</sub>	<i>Campylobacter</i>

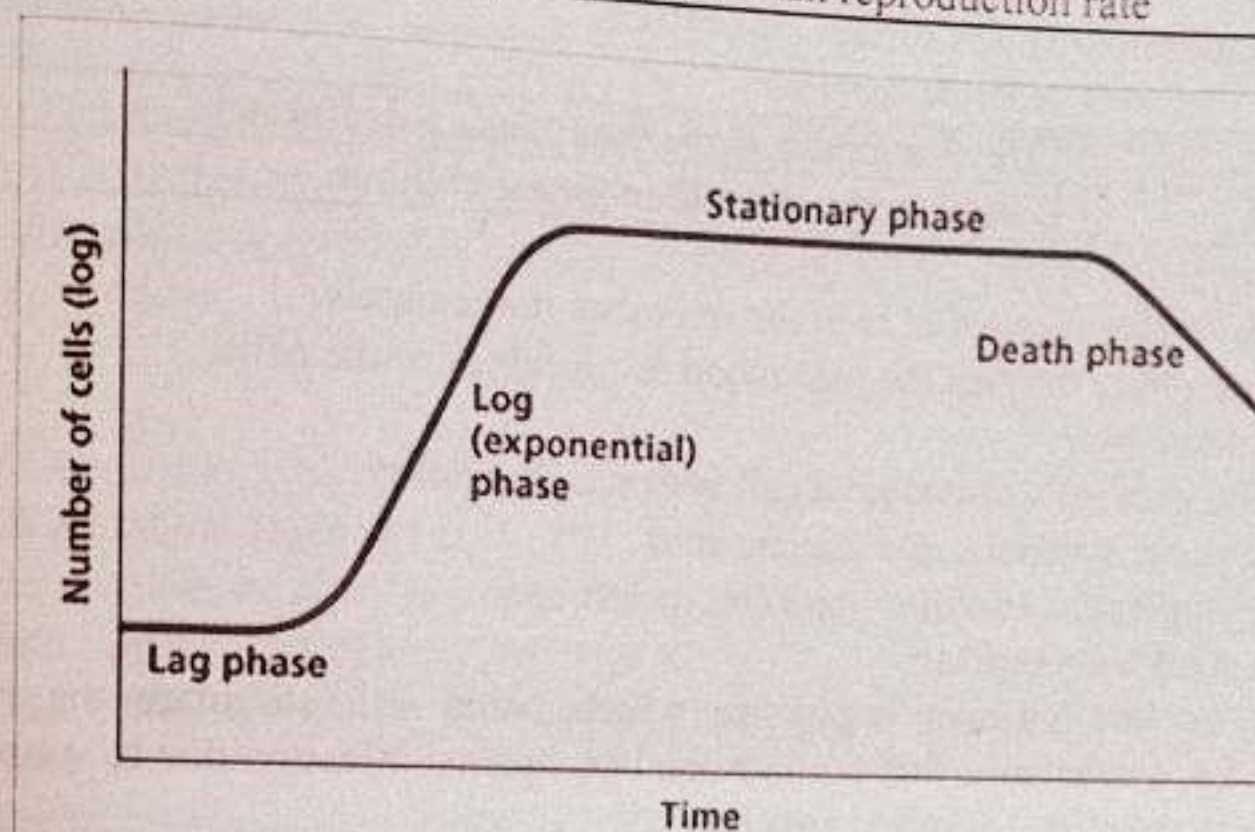
GROWTH AND REPRODUCTION

- Bacteria increase in number by asexual means of reproduction called *binary fission*.
- The interval of time until the completion of next division is known as *generation time*.
- Bacterial lack traditional sexual reproduction and mitosis.
- Transfer of genetic material from a donor bacterium to a recipient during a process called *conjugation*.





PHASE	FEATURE
Lag phase	No growth
Log phase	Rapid growth at exponential ratio
Stationary phase	Death rate equal to rate of reproduction
Death/ decline phase	Death rate more than reproduction rate



### IMPORTANCE OF BACTERIA

- Ecologically bacteria are important as decomposers.
- About 200 species are known to cause diseases in humans

### CONTROL OF BACTERIA

Controlling microorganisms may help in preventing and treating diseases, preventing food spoilage and spoilage of industrial products.

#### **Physical Methods**

- The process in which we use physical agents to control bacteria/ microorganisms is called **sterilization**.
- **Sterilization** is destruction of all life forms.
- **Moist heat (steam)** causes coagulation of proteins thus kills the microorganisms.
- **Dry heat** causes oxidation of chemical constituents of microbes and thus kills them.
- **Electromagnetic radiations below 300 nm** are effective in killing microorganisms e.g.,  $\gamma$  radiations.
- **Filtration** is used in sterilization of heat sensitive compounds like antibiotics, sera, hormones, etc.

#### **Chemical Methods**

- Chemical substances used on living tissues that inhibit the growth of micro organism are called **antiseptics**.
- The important chemical agents used for **disinfection** are oxidizing and reducing agents e.g., Halogens, phenols,  $H_2O_2$ ,  $KMnO_4$ , alcohol and formaldehyde.
- **Chemotherapeutic chemical substances** are used in the treatment of infectious disease.
- **Antibiotics** destroy or inhibit the growth of microorganisms in living tissue.
- They work with natural defense and stop the growth of bacteria and other microbes.





## Chapter 6

## Kingdom Monera

- They may be *natural* as synthesized by bacteria, actinomycetes and fungi or *synthetic* as prepared in laboratories from living cell.

## Misuse Of Antibiotics

- Massive use of antibiotics leads to *drug resistance*. This cause ineffective antibiotic coverage.
- Misuse of antibiotics causes certain side effects.

Penicillin	Allergic reactions
Streptomycin	Effects auditory nerve thus causing deafness.
Tetracyclin	Discoloration of teeth in young children.

- Microbicidal effect** is one that kills the microbes immediately.
- Microbistatic effect** inhibits the reproductive capacities of the cells.

Antibiotics work by:

- Inhibiting the synthesis of bacterial cell wall e.g., Penicillin.
- Inhibiting protein synthesis and nucleic acid.
- Inhibiting cytoplasmic enzymes, and cell membrane.

## Immunization And Vaccination

- Attenuated or less virulent organisms which could still stimulate the host to produce antibodies, i.e. a substance that protects the host against infection due to subsequent exposure to the virulent organism is called *vaccine*.

## Contribution of Louis Pasteur

- He *isolated* the bacterium responsible for chicken cholera and demonstrated that Chickens fail to get infection if previously exposed to attenuated form of bacteria.
- He also applied the principle of *inoculation* with attenuated cultures to the prevention of anthrax.
- He coined the *name vaccine* (from Latin 'Vacca' meaning 'Cow') to the attenuated cultures of bacteria.
- He also *developed a vaccine* against hydrophobia or rabies, a disease resulting from bite of infected carnivorous animals like bats and dogs.

## Contribution of Edward Jenner

He first time vaccinated a boy against *small pox*.



- Chemosynthetic bacteria oxidize \_\_\_\_\_ compounds.
- Phase of no bacterial growth is \_\_\_\_\_.
- \_\_\_\_\_ is destruction of all life forms.
- \_\_\_\_\_ effect is one that kills the microbes immediately.
- \_\_\_\_\_ is used in sterilization of heat sensitive compounds.

Answers: (1) Inorganic (2) Lag phase (3) Sterilization (4) Microbicidal (5) Filtration



CYANOBACTERIA

- The cyanobacteria or blue green algae are the *largest and most diverse group of photosynthetic bacteria*.
- They are *true prokaryotes*.

**Structure**

- Their *diameter* is 1- 10  $\mu\text{m}$ .
- Generally they are *unicellular, colonial* (with many shape) or *filamentous* (consisting of trichomes, chains of cell) surrounded by mucilaginous sheath.
- Cyanobacteria have normal *gram -ive cell wall*.
- They *lack flagella*, often use *gas vesicles* to move in water, while many filamentous species have gliding motility.

**Nutrition**

- Their photosynthetic system closely resembles that of eukaryotes because they have *chlorophyll a* and *photosystem II*.
- They utilize water as an electron donor and generate  $\text{O}_2$  during photosynthesis.
- They contain *phycobilins* as accessory pigments.
- *Phycocyanin* (blue) is their predominant phycobilin and  $\text{CO}_2$  in them is assimilated through calvin cycle.
- Photosynthetic pigments and electron transport chain components are located in thylakoid membranes linked with particles called *phycobilisomes*.
- *Reserve food* material in cyanobacteria is *glycogen*.

**Reproduction**

They reproduce by *binary fission* or *fragmentation*. Sexual reproduction is not found at all.

**ECONOMIC IMPORTANCE**

- *Reclamation of alkaline soil*.
- *Fixation of atmospheric nitrogen* in those having heterocyst.
- *Release of  $\text{O}_2$*  due to photosynthetic activity.
- *Oscillatoria* and few other cyanobacteria can be used as *pollution indicators*.
- They may be *symbiotic* (with protozoa and fungi), nitrogen fixing (relation with angiosperms) or photosynthetic partner in most of lichen associations.
- These species impart *unpleasant smell* and due to large amount of suspended organic matter water becomes unfit for consumption.
- Some species produce *toxin* that kill live stock and other animals that drink the water.
- *Super blue green algae* are basically expensive pond scum. It serves as a complete whole food, containing 60 % proteins with all the essential amino acids in perfect balance.

NOSTOC

- *Nostoc* is present in *terrestrial and subaerial environment*.
- *Nostoc* is widely distributed in *alkaline soils* and on moist rocks and cliffs.
- *Trichome* consisting of spherical or barrel shaped or cylindrical cells.
- Light yellow thick walled cells in trichome are called *heterocyst*.





- It breaks near heterocyst and forms *hormogonia*.
- *No sexual reproduction*.
- Reproduce asexually by formation of hormogonia and also by akinete formation.
- *Akinetes* are thick walled enlarged vegetative cells which accumulate food and become resting cells. They form normal vegetative cells on arrival of favourable conditions.



1. Cyanobacteria have \_\_\_\_\_ cell wall.
2. Cyanobacteria contain \_\_\_\_\_ as accessory pigment.
3. \_\_\_\_\_ are basically expensive pond scum.
4. Nostoc is widely distributed in \_\_\_\_\_ soil.
5. Cyanobacteria use \_\_\_\_\_ to move in water.
6. \_\_\_\_\_ cells in cyanobacteria are involved in nitrogen fixation.

Answers: (1) Gram -ive (2) Phycobillin (3) Super blue green algae (4) Alkaline (5) Gas vesicles (6) Heterocyst



## VALUES

Property	Value
Postulates of germ theory	4
Range of size of bacteria	0.1-600 $\mu\text{m}$
Size of <i>Mycoplasma</i>	100-200 nm
Size of <i>E. Coli</i>	1.1-1.5 $\mu\text{m}$ (wide), 2.0-6.0 $\mu\text{m}$ (long)
Size of <i>spirochete</i>	500 $\mu\text{m}$
Size of <i>Staphylococci</i> & <i>Streptococci</i>	0.75-1.25 $\mu\text{m}$
Size of <i>Epulopiscium fishelsoni</i>	600 $\mu\text{m}$ (long), 80 $\mu\text{m}$ (wide)
Number of cocci in tetrad	4
Number of cocci in sarcina	8
Measurement of close circle chromosome of <i>E. Coli</i>	1,400 $\mu\text{m}$
Diameter of cyanobacteria	1-10 $\mu\text{m}$





## PRACTICE EXERCISE

 30 mins  
Time Yourself

- The word Archaeobacteria, (a division of bacteria) derived from Greek means
  - True bacteria.
  - False bacteria.
  - Recent bacteria.
  - Ancient bacteria.
- Who coined the term 'Animalcules' for microorganisms like Bacteria and protozoa?
  - Robert Koch.
  - Louis Pasteur.
  - Alexander Fleming.
  - Leeuwenhoek.
- Who discovered the bacteria causing tuberculosis and also developed various techniques of media preparation, and maintenance of pure culture?
  - Robert Koch.
  - Louis Pasteur.
  - Alexander Fleming.
  - Leeuwenhoek.
- Which of the following statement is incorrect regarding germ theory of diseases postulated by Robert Koch?
  - A specific organism can always be found in association with a given disease
  - The organism can be isolated and grown in pure culture in the laboratories.
  - The pure culture cannot produce the disease when inoculated into susceptible animal, however the causative organism isolated from pure culture can do so.
  - It is possible to recover the organism in pure culture from the experimentally infected animals.
- Which of the following structure is not present in all the bacteria?
  - Cell membrane
  - Chromatin bodies.
  - Ribosomes
  - Capsule
- The size of Spirochete is
  - 0.1-600  $\mu\text{m}$
  - 100-200 nm
  - 500  $\mu\text{m}$
  - 0.75-1.25  $\mu\text{m}$
- E. coli*, an example of enterobacteriace, is important for causing diarrheal diseases, its size is:
  - 0.1-600  $\mu\text{m}$
  - 100-200 nm
  - 1.1-1.5  $\mu\text{m}$  (width), 2.0-6.0  $\mu\text{m}$  (length)
  - 0.75-1.25  $\mu\text{m}$
- In bacterial categories the bacteria smaller in number are
  - Gram -ive bacteria
  - Eubacteria
  - Ancient bacteria
  - Gram +ive bacteria
- Germ theory of disease has \_\_\_\_\_ postulates
  - 3
  - 5
  - 4
  - 6
- Some bacteria ranging occasionally a size of 500  $\mu\text{m}$  in length are
  - Escherichia coli
  - Spirochetes
  - Mycoplasma
  - Epulopiscium
- Coccobacillus has a shape similar to
  - Diplobacillus
  - Sarcina
  - Egg
  - None of these
- The first bacterium isolated was
  - Coccus
  - Bacillus
  - Vibrio
  - Spirochete





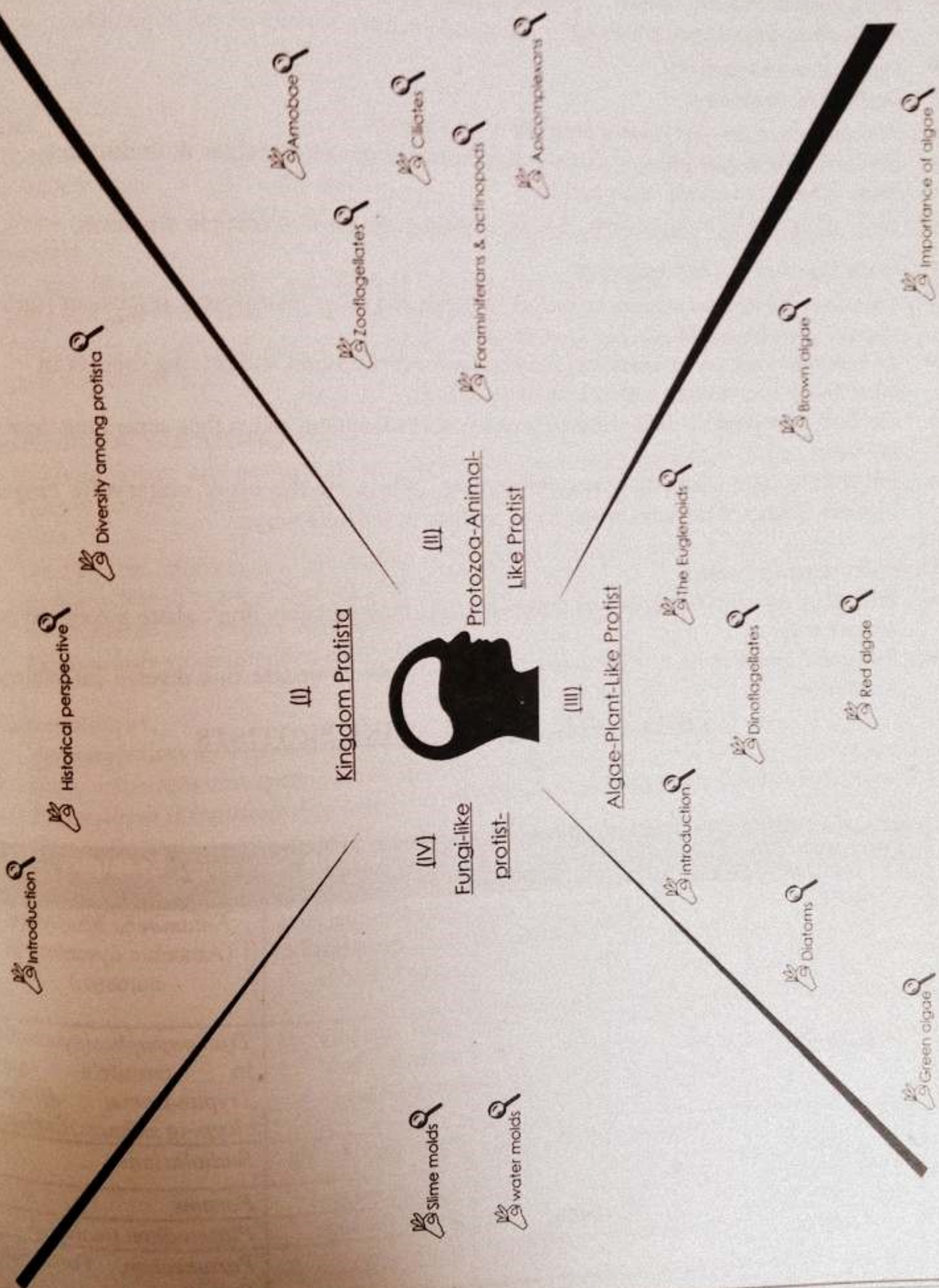
13. Which of the following bacteria are thick, rigid and spiral?  
 (a) Vibrio (b) Spirillum  
 (c) Spirochete (d) Coccus
14. A group of 8 cocci is called  
 (a) Diplococci. (b) Octococci.  
 (c) Tetrad. (d) Sarcina
15. Which of the following has a chain arrangement?  
 (a) Streptobacillus (b) Streptococci.  
 (c) Staphylococci. (d) Both A and B.
16. Which of the following bacteria do not have flagella commonly?  
 (a) Cocci (b) Bacilli.  
 (c) Streptobacilli. (d) Vibrio.
17. Flagella originate from  
 (a) Cell membrane. (b) Cell wall.  
 (c) Capsule. (d) Basal body.
18. A bacterium with tuft of flagella at both poles is called  
 (a) Lophotrichus (b) Monotrichous  
 (c) Peritrichous (d) Amphitrichous
19. Which of the following structure primarily helps in attachment of bacteria on various surfaces?  
 (a) Flagella. (b) Pili  
 (c) Both of these (d) None of these
20. Which of the following structure provides greater pathogenicity to the bacteria?  
 (a) Capsule. (b) Slime  
 (c) Cell wall. (d) Cell membrane.
21. Cell wall is absent in  
 (a) Cocci. (b) Bacilli.  
 (c) Mycobacterium (d) Mycoplasma.
22. Cell wall of Archaeobacteria does not contain  
 (a) Peptidoglycan (b) Proteins.  
 (c) Glycoproteins (d) Polysaccharides
23. Gram positive bacteria appear  
 (a) Purple. (b) Red  
 (c) Pink (d) Blue
24. Extremely long molecule of DNA that is tightly folded to fit inside the cell component is called  
 (a) Nucleus (b) Chromosome  
 (c) Chromatid. (d) Chromatin body
25. Which of the following contains genes for drug and disease resistance in bacteria?  
 (a) Nucleotide. (b) Plasmid.  
 (c) Mesosome (d) Ribosome.
26. The common waste material in bacteria is  
 (a) Glycogen (b) Lactic acid  
 (c) Ammonia (d) Urea
27. Example of bacteria requiring low concentration of oxygen is  
 (a) Campylobacter (b) spirocheta  
 (c) E-coli (d) Pseudomonas





28. **Purple non- sulphur bacteria** is an example of  
 (a) Heterotrophic bacteria. (b) Chemosynthetic bacteria  
 (c) Photosynthetic bacteria (d) Saprotrophic bacteria
29. **Those bacteria which are fully dependent upon their host for nutrition** are called  
 (a) Heterotrophic bacteria. (b) Chemosynthetic bacteria  
 (c) Saprophytic bacteria (d) Parasitic bacteria.
30. **Nitrifying bacteria** are the examples of  
 (a) Heterotrophic bacteria. (b) Chemosynthetic bacteria  
 (c) Saprophytic bacteria (d) Parasitic bacteria.
31. **E. Coli** is an example of  
 (a) Aerobic bacteria (b) Anaerobic bacteria  
 (c) Facultative bacteria (d) Microaerophilic
32. **Spirochete** is an example of  
 (a) Aerobic bacteria (b) Anaerobic bacteria  
 (c) Facultative bacteria (d) Microaerophilic
33. **Sex pili** is formed in which of the following processes:  
 (a) Binary fission. (b) Mitosis.  
 (c) Sexual reproduction. (d) Conjugation.
34. **Rapid growth at exponential ratio** occurs in which phase of bacterial growth:  
 (a) Lag phase (b) Log phase  
 (c) Stationary phase (d) Death/ decline phase
35. **Chemical substances used on living tissues that inhibit the growth of microorganism** are called  
 (a) Antiseptics. (b) Disinfectants.  
 (c) Antibiotics. (d) Vaccines.
36. **Who developed the vaccine against anthrax?**  
 (a) Louis Pasteur (b) Edward Jenner  
 (c) Leuwenhoek (d) Alexander Fleming.
37. **Cyanobacteria** have \_\_\_\_\_ cell wall.  
 (a) Gram + ve. (b) Gram - ve.  
 (c) Acid fast. (d) Cellulose rich.
38. **Which of the following help cyanobacteria to locomote?**  
 (a) Flagella. (b) Gas vesicles.  
 (c) Both of these. (d) None of these.
39. **Cyanobacteria** reproduce by:  
 (a) Binary fission. (b) Mitosis.  
 (c) Meiosis. (d) Conjugation
40. **Approximately \_\_\_\_\_ species of bacteria are known to cause diseases in humans.**  
 (a) 100 (b) 200  
 (c) 300 (d) 400







## INTRODUCTION AND HISTORICAL PERSPECTIVE

- The kingdom Protista consist of primarily aquatic eukaryotic unicellular, colonial or simple multicellular organisms, which are:
  - *Difficult to characterize.*
  - *Defined by exclusion.*
  - Protists *do not develop from a blastula* or an embryo.
  - Contains *four major groups*, single cell protozoans, unicellular algae & multicellular Algae, slime molds and water molds.
- John Hogg** in 1861 proposed the kingdom protocista for microscopic organism.
- Ernst Haeckel** in 1866 suggested:
  - *Creation of kingdom protista* to include bacteria and other microscopic organisms (such as euglena) that do not fit into plants or animals.
  - *To separate blue green algae* and bacteria from other protists and placing them in an other group i.e., monera within kingdom protista.
- Herbert Copeland** in 1938 elevated prokaryotes to kingdom status thus separating them from protista.
- All the protists evolved from prokaryotes. While all the other eukaryotic kingdoms Plantae, Fungi, Animalia arose from protists in various ways.

### Diversity Among Protists

- Protista is *polyphyletic group* of organisms, i.e., they probably don't share a common group of ancestors.
- Margulis and Schwartz** have listed 27 phyla to accommodate this diverse assemblage of organisms

## PROTOZOA: ANIMAL - LIKE PROTISTS

All are unicellular and ingest food by endocytosis.

Common Name	Form	Existence	Locomotion	Examples
Amoebas	Unicellular	Free living	Pseudopodia(false feet) cytoplasmic projections.	<i>Entamoeba histolytica</i> (Amoebic dysentery in humans.)
Zooflagellates	Unicellular, some colonial	Free living, Parasitic or symbiotic.	One (usually at anterior end) or more flagella	<i>Trichonymphas</i> (symbiotic in termite's gut) <i>Trypanosoma</i> (African sleeping sickness) <i>Euglena</i>
Actinopods	Unicellular	Free living	Pseudopods	<i>Radiolarians</i>
Foraminifera	Unicellular	Free living	Pseudopods	<i>Forams</i>
Apicomplexans	Unicellular	Parasitic	None, flexing.	<i>Plasmodium</i> (malaria)
Ciliates	Unicellular	Free living	Cilia	<i>Paramecium</i> , <i>Vorticella</i> , <i>Stentor</i>



**Zooflagellates**

- *Trichonymphas* are complex, specialized Flagellates with many flagella which live as symbionts in the guts of termites and help in the digestion of dry wood.
- *Choanoflagellates* are sessile marine or freshwater flagellates, which are attached by a stalk, and a delicate collar surrounds their single flagellum.
- Choanoflagellates are of special interest because of their striking resemblance to collar cells in sponges.

**Ciliates**

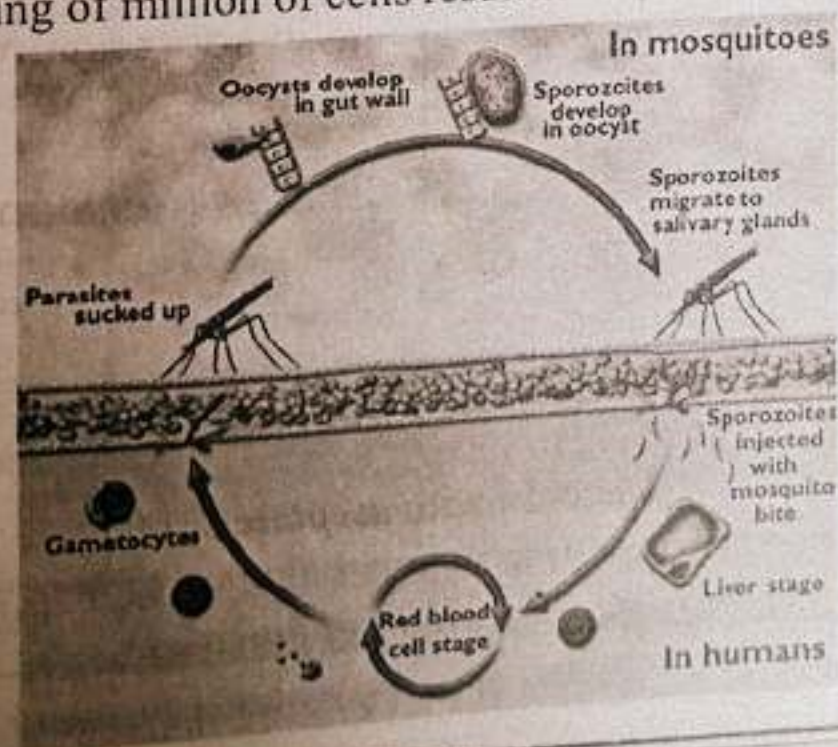
- They are unicellular organism with a flexible outer covering called a *pellicle* that gives them a definite shape, which is changeable.
- Water regulation in freshwater ciliates is controlled by special organelles called *contractile vacuole*.
- Ciliates have two nuclei i.e. *diploid micronuclei* functioning in sexual process whereas *polyploid macronucleus* that controls cell metabolism and growth.
- Ciliates are capable of sexual reproduction called *conjugation* during which they transfer their genetic material.

**Foraminiferans and Actinopods**

- *Foraminiferans and actinopods* are marine protozoans which produce shells (or tests).
- *Tests* of foraminiferans are made up of calcium whereas those of actinopods are made up of silica.
- Dead foraminiferans sink to the bottom of the ocean where their shells form a grey mud that is gradually transformed into *chalk*.
- Foraminiferans of the past have created vast *limestone deposits*.
- *Radiolarians* are actinopods with glassy shells.

**Apicomplexans**

- *Apicomplexans* lack specific structures for locomotion but move by flexing.
- Many apicomplexans spend part of their life in *one host* and part in a *different host species*.
- *Plasmodium* is transmitted to man by a bite of an infected *female anopheles mosquito*.
- Upon entry, gain access to liver cells, then in RBC, where they multiply, and upon bursting of R.B.C newly formed plasmodium infect other R.B.Cs.
- Simultaneous bursting of million of cells result chills, fever from number of toxic substances.





THE ALGAE: PLANT LIKE PROTISTS

- Algae are *photosynthetic protists*, carrying out probably 50-60% of all the photosynthesis on earth.
- A body which is not differentiated into true roots, stem and leaves and lack xylem and phloem is called "*Thallus*"
- Algal life cycle show extreme variation but, all algae except members of phylum rhodophyta have forms with *flagellated motile cells* in at least one of stage of their life cycle.



- There are \_\_\_\_\_ major groups of protists.
- All protozoans are unicellular & ingest food by \_\_\_\_\_.
- Ciliates have a flexible outer covering called \_\_\_\_\_.
- \_\_\_\_\_ are actinopods with glassy shell.
- Plasmodium enters in human in form of \_\_\_\_\_.

Classification of the Photosynthetic Protocists

Phylum	Common Name	Form	Locomotion	Pigments	Examples
Euglenophyta	Euglenoids	Unicellular	Two flagella one long one short	Chl.a, Chl.b, Carotenoids	<i>Euglena</i>
Phyrrrophyta	Dinoflagellates	Unicellular	Two flagella	Chl.a, Chl.c, Carotenes including Fucoxanthin	<i>Gonyaulax</i> , <i>Ceratium</i>
Chrysophyta	Diatoms	Usually unicellular	Usually none	Same as above	<i>Diatoma</i> , <i>Frequilaria</i> , <i>Pinnularia</i>
Phaeophyta	Brown algae	Multicellular	Two flagella on reproductive cells	Same as above	<i>Fucus</i> , <i>Macrocystis</i>
Rhodophyta	Red algae	Multicellular or unicellular	None	Chl.a, Carotenes, Phycoerythrin	<i>Chondrus</i> , <i>polysiphonia</i>
Chlorophyta	Green algae	Unicellular, colonial, multicellular	Most flagella have	Chl.a, Ch.b, carotenes	<i>Chlorella</i> , <i>Ulva</i> , <i>Acetabularia</i> , <i>spirogyra</i>

Answers: (1) Four (2) Endocytosis (3) Pellicle (4) Radiolarians (5) Sporozoites



- Based on molecular data, euglenoids are thought to be *closely related to zooflagellates*.
- Some photosynthetic euglenoids lose their chlorophyll when grown in dark and obtain their nutrients *heterotrophically* by ingesting organic matter.

### Dinoflagellates

- One of the most *unusual protist phyla* is that of Dinoflagellates.
- Most dinoflagellates are *unicellular*.
- Their cells are often covered with shells of *interlocking cellulose plates* impregnated with silicates.
- They are *second to Diatoms* as an important producer groups in marine life.
- Dinoflagellates are known to have occasional populations or *blooms*. These blooms frequently colour the water orange red or brown and are known as "*Red tides*".

### Diatoms

- Diatoms are the *major producers* in aquatic marine and freshwater ecosystem because of their extremely large numbers. Diatoms are very important in aquatic food chains.
- In diatoms silica is deposited in the shell and this *glasslike* material is laid down in intricate pattern.

### Brown Algae

- Brown algae include the *giants of the protist kingdom*.
- All brown algae are *multicellular* and range from a few centimeters to approximately 75 meters in length.
- Largest brown algae i.e. *kelps* possess leaf-like *blades*, stem-like *stipe* and root-like anchoring "*holdfast*".
- Brown algae are common in *cooler marine waters* especially along rocky coastlines in the inter-tidal zone.
- *Fucus* is brown algae.

### Red Algae

- A few red algae are *flattened sheets of cells*.
- Some red algae incorporate *calcium carbonate* in their cell walls from the ocean and take part in building coral reefs alongwith coral animals.

### Green Algae

- In green algae, the main energy reserves are stored as *starch*.
- Most green algae possess cell wall with *cellulose*.
- It is generally accepted that plants arose from *ancestral* green algae.
- Green algae *desmids* have cells with two halves.
- *Chlorella* is a uni-cellular, non motile green algae.

### Importance Of Algae

- Marine algae are also *source of many useful substances* like algin, agar carrageenan and antiseptics.
- *Kelps* are edible and can be used to overcome the shortage of food.





- Algae like diatoms & dinoflagellates are the major producers of the marine ecosystem providing food and the oxygen to other organisms.

### FUNGUS LIKE PROTISTS

There are *two major groups* of fungi-like protist i.e. slime molds and water molds.

#### FUNGUS vs FUNGUS LIKE PROTISTS:

##### SIMILARITIES

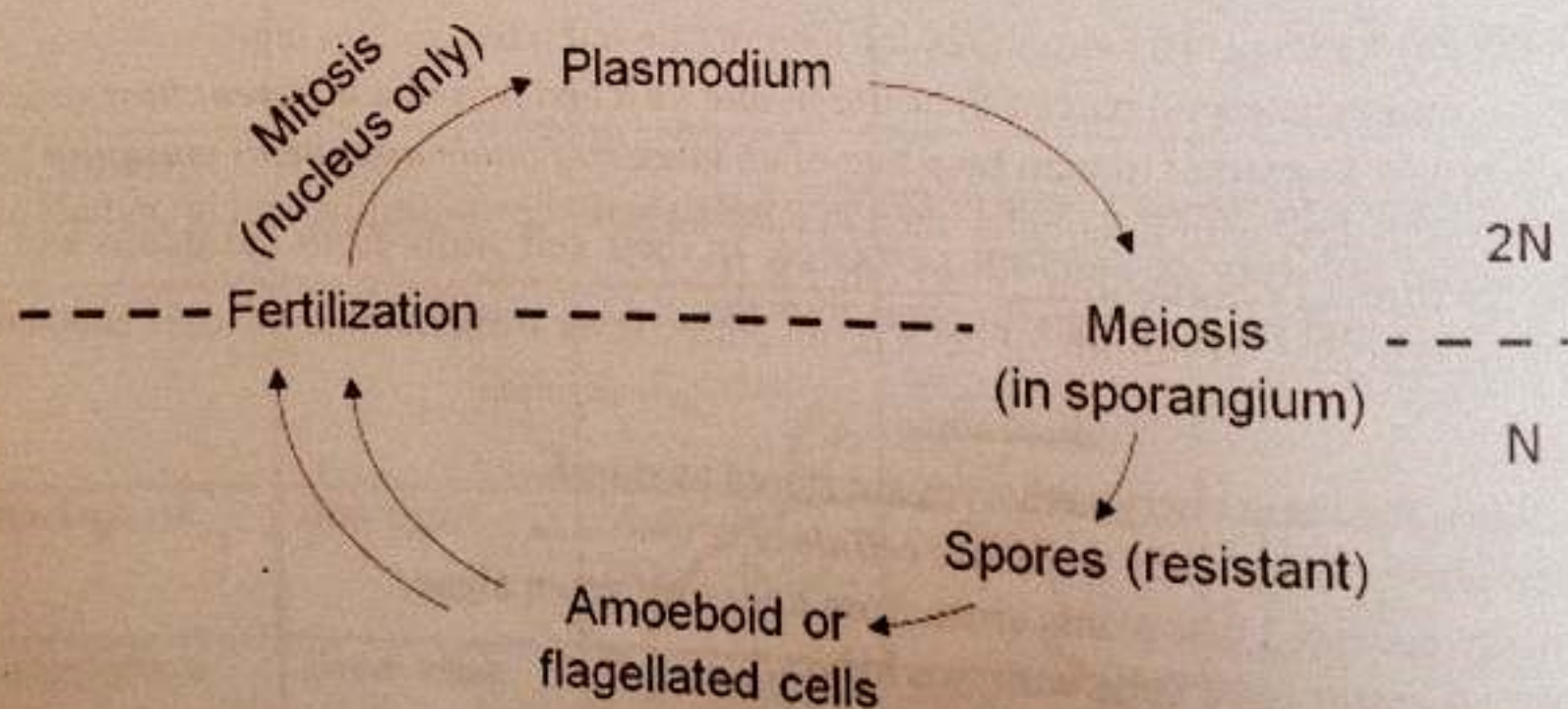
- Both are not photosynthetic.
- Formed of thread like structures called hyphae.

##### DIFFERENCES:

- These protists have centrioles.
- Cell wall is made of cellulose. While that of fungi's is made of chitin.

#### Slime Molds Or Myxomycetes

- The **feeding stage** of a slime mold is a plasmodium, a multinucleate mass of cytoplasm that can grow to 30cm (1ft) in diameter. Plasmodium is a naked mass of cytoplasm having many nuclei.
- Reproductive structures** of slime molds are stalked sporangia.
- Sporangia** produce haploid spores meiosis formed during unfavorable conditions.
- In slime molds under favourable condition, the spores germinate into *biflagellated or amoeboid reproductive or swarm cells*, which unite to form diploid zygote.
- The plasmodial slime mold *Physarum polycephalum* is the model organism that has been used in many fundamental biological processes such as growth and differentiation, cytoplasmic streaming and the function of cytoskeleton.



#### Water Molds Or Oomycetes

- Their cell wall contains *cellulose*, not chitin with *aseptate hyphae*.
- Phytophthora infestans* was the cause of Irish potato famine of the 19<sup>th</sup> century.
- It causes a disease commonly known as *late blight of potatoes*.





1. Most dinoflagellates are \_\_\_\_\_.
2. \_\_\_\_\_ are major producers in aquatic ecosystem.
3. *Fucus* is \_\_\_\_\_ algae.
4. In green algae, main energy reserves are \_\_\_\_\_.
5. Cell wall of fungi-like protists is made of \_\_\_\_\_.
6. The feeding stage of slime mold is \_\_\_\_\_.

### VALUES

Property	Value
Number of phyla by Margulis & Schwartz for protists	27
Range of length of Brown algae	Few centimeter to 75 meter
Maximum diameter of feeding stage of slime mold	30 cm (1 ft)





## PRACTICE EXERCISE



1. Which of the following statement about Kingdom Protista is incorrect?
  - (a) Their members have characteristics which separate them from other kingdoms.
  - (b) They only include unicellular aquatic eukaryotic organisms.
  - (c) They don't develop from Blastula or embryo.
  - (d) They contain ancestors for fungi, plants & animals.
2. Who first separated bacteria from other protists as a group?
  - (a) John Hogg
  - (b) Ernst Haeckel
  - (c) Margulis and Schwartz
  - (d) Herbert Copeland
3. Which of the protozoa has a striking resemblance to collar cells in sponges?
  - (a) Zooflagellates.
  - (b) Choanflagellates.
  - (c) *Trypanosoma*.
  - (d) *Trichonymphas*
4. Radiolarians belong to which of the following protozoal group?
  - (a) Zooflagellates
  - (b) Actinopods
  - (c) Foraminifera
  - (d) Apicomplexans
5. Which of the following statement about ciliates is incorrect?
  - (a) Contain mainly unicellular organisms.
  - (b) Their contractile vacuole is responsible for water regulation.
  - (c) They are even capable of sexual reproduction.
  - (d) Diploid nucleus being smaller is responsible for cell's metabolism and growth, while polyploidy nucleus functions in sexual process.
6. Lime stone deposits are formed from
  - (a) Zooflagellates
  - (b) Foraminiferans
  - (c) Actinopods
  - (d) Apicomplexans
7. Plasmodium belongs to
  - (a) Ciliates
  - (b) Apicomplexans
  - (c) Actinopods
  - (d) Foraminiferans
8. Kingdom protista includes \_\_\_\_\_ phyla
  - (a) 27
  - (b) 28
  - (c) 26
  - (d) 29
9. Stentor is a/an
  - (a) Ciliate
  - (b) Foraminiferan
  - (c) Actinopod
  - (d) Apicomplexan
10. Complex specialized flagellates living symbiotically in the gut of termites are
  - (a) *Trichonymphas*
  - (b) *Trypanosoma*
  - (c) *Euglena*
  - (d) Radiolarians
11. The definite shape to ciliates is given by
  - (a) Pellicle
  - (b) Penicle
  - (c) Calcium
  - (d) Cell wall
12. Chalk is gradually formed of dead
  - (a) Actinopods
  - (b) Foraminiferans
  - (c) Apicomplexans
  - (d) Radiolarians





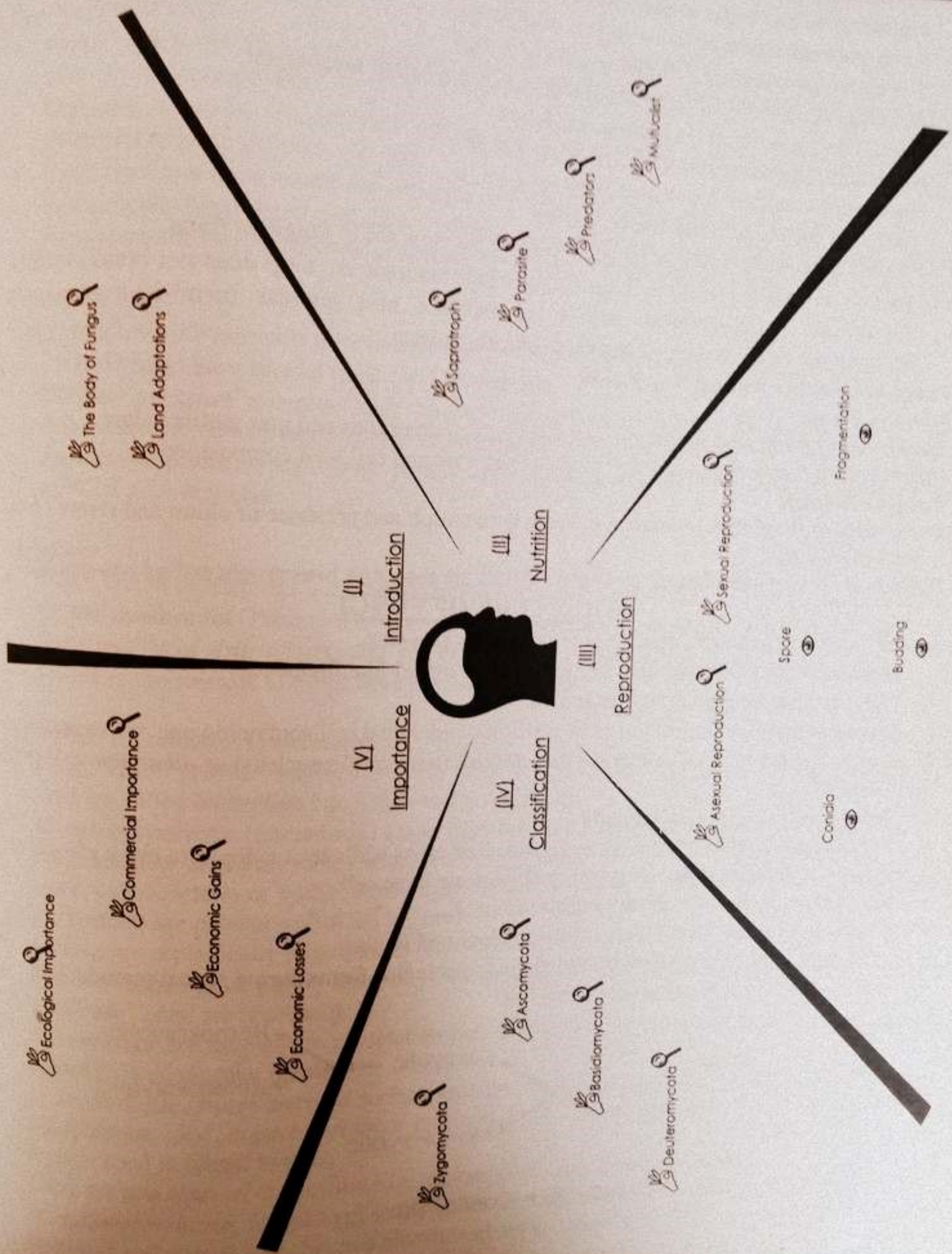
13. Of the following, which one has glassy shells?  
 (a) Radiolarians  
 (c) Both of these  
 (b) Forams  
 (d) None of these
14. Which of the following statement is incorrect about algae?  
 (a) Their zygote unlike plants is protected by parental tissue.  
 (b) Their classification is based on pigment composition.  
 (c) Most of them have different morphological forms in different stages of their life cycle.  
 (d) Almost all of them are aquatic.
15. In which of the following pigments, major energy reserves and cell wall are like plants?  
 (a) Rhodophyta  
 (c) Phaeophyta  
 (b) Chlorophyta  
 (d) Chrysophyta
16. Most of the photosynthesis on earth is carried by  
 (a) Kelps  
 (c) Angiosperms  
 (b) Gymnosperms  
 (d) Algae
17. The only group of algae having no flagellated motile cells at any stage is  
 (a) Chrysophyta  
 (c) Pyrrophyta  
 (b) Phaeophyta  
 (d) Rhodophyta
18. Brown algae are also known as  
 (a) Phaeophyta  
 (c) Pyrrophyta  
 (b) Rhodophyta  
 (d) Chrysophata
19. Golden algae are also known as  
 (a) Chrysophyta  
 (c) Pyrrophyta  
 (b) Phaeophyta  
 (d) Rhodophyta
20. Based on molecular data, euglenoids are thought to be closely related to  
 (a) Dinoflagellates  
 (c) Protozoans  
 (b) Zooflagellates  
 (d) Algae
21. All photosynthetic euglenoids lose their chlorophyll when grown in dark and obtain their nutrients heterotrophically this statement is  
 (a) True  
 (c) May be true may be false  
 (b) False  
 (d) Unpredictable
22. Most dinoflagellates are  
 (a) Unicellular  
 (c) Both of these  
 (b) Multicellular  
 (d) Zooflagellates
23. The most important group of producers in marine ecosystem is of  
 (a) Diatoms  
 (c) Dinoflagellates  
 (b) Euglenoids  
 (d) Brown algae.
24. Of the following, which one is not the characteristic of dinoflagellates  
 (a) Most of them are unicellular  
 (b) They have blooms  
 (c) Their cells are often covered with shells of interlocking cellulose plates impregnated with calcium  
 (d) None of these
25. Examples of Rhodophytes are  
 (a) Chondrus  
 (c) Both of these  
 (b) Polysiphonia  
 (d) Pinnularia





26. In chlorophytes, the main energy stores are  
(a) Cellulose (b) Starch  
(c) Glycogen (d) All of these
27. Of the following, which one is not the characteristic of green algae?  
(a) Some green algae possess cell wall with cellulose  
(b) They are generally accepted as the ancestors of green plants  
(c) Chlorella is unicellular non-motile green algae  
(d) None of these.
28. In slime molds spores develop into  
(a) Swarm cells (b) Biflagellated cells  
(c) Amoeboid reproductive cells (d) All of these.
29. Spores produced by slime molds are  
(a) Haploid (b) Diploid  
(c) Triploid (d) None of these.
30. Which of the following is responsible for Irish potato famine?  
(a) Dinoflagellates (b) Kleps  
(c) *Physarum polycephalum* (d) *Phytophthora infestans*







INTRODUCTION

- Fungi usually prefer *moist habitat*.
- They can tolerate *pH* range of 2-9, a wide temperature range and high osmotic pressure e.g., concentration salt/ sugar solution as in jelly and jam.
- Fungi store *extra food* as lipid droplets or glycogen.
- There are approximately *100,000 species* of fungi.
- *Mycology* is the study of fungi and the scientists are called *mycologist*.
- Rusts, smuts and molds are *pathogenic fungi*.
- Mushrooms, morels and truffles are *edible fungi*.
- *Antibiotic* penicilline is obtained from *Penicillium*.
- *Yeasts* are used in bakeries and breweries.
- Initially fungi were placed in kingdom plantae but now are in *kingdom fungi*.
- *Nuclear mitosis* is present in fungi during which nuclear envelop does not break; instead the mitotic spindle forms within the nucleus and nuclear membrane constricts between the two clusters of daughter chromosomes.

**Fungi Are Neither Animal Nor Plants****Fungi vs Plants**

*Similarities of fungi with plants* are: cell wall, lack of centrioles and non-motile nature.

*Differences of fungi with plants* are: mode of nutrition and cell wall composition.

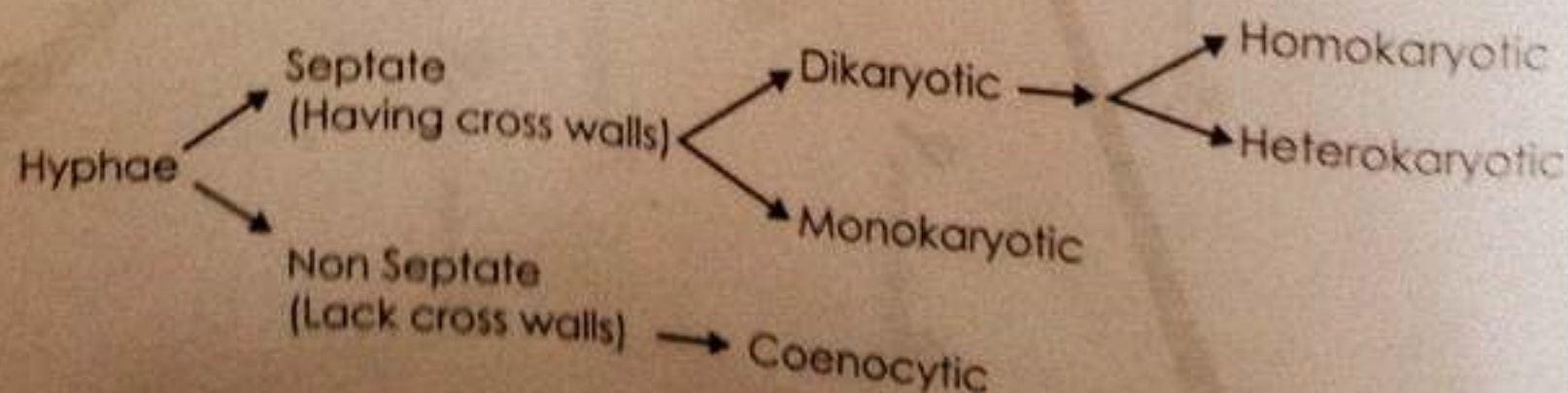
**Fungi vs Animals**

*Similarities of fungi with animals* are: being heterotroph and presence of chitin and reserve food in form of glycogen.

*Differences of fungi with animals:* they have cell wall, are absorptive heterotrophs and are non-motile.

STRUCTURE OF FUNGI

- All fungi are *multicellular* (except yeast) and *eukaryotes*.
- *Hyphae* are long, slender, branched and tubular thread-like filaments.
- They are of *two types* i.e. septate and aseptate.
- *Septate hyphae* are divided by cross walls into individual cell containing one or two nuclei.
- Septate hyphae may contain *monokaryotic* cell (with single nucleus) or *dikaryotic* cell (with two nuclei).
- *Septa* of most hyphae have pores.
- *Non-septate hyphae* or coenocytic hyphae lack cross walls thus cytoplasm move effectively and are in the form of an elongated multinucleate large cell.
- Non-septate hyphae are always *multinucleated*.
- *Chitin* is more resistant to decay than cellulose and lignin.
- All fungal nuclei are *haploid* except diploid zygote that forms during sexual reproduction.
- *Yeast* is non- hyphal unicellular fungi.





Fungi are absorptive heterotrophs i.e. they lack chlorophyll, thus can't synthesize their own food, instead obtain it from their immediate environment via absorption.

### Saprotrophic Fungi

- Fungi, which get their food directly from dead organic matter, are called *saprotrophs*, saprobes or decomposers.
- Digestive enzymes are secreted out to digest dead organic matter into small organic molecules to be absorbed in the cell.
- Fungi are major decomposers of cellulose and lignin (most bacteria cannot break them).
- Saprotrophic fungi have root-like hyphae called rhizoids. They anchor the fungi on the substratum and provide enormous surface for absorptive mode of nutrition.

### Parasitic Fungi

Fungi, which absorb nutrients directly from the living host cytoplasm are called *parasites*.

- Parasitic fungi have special roots called *haustoria*.
- *Obligate parasites* can grow only on their living host and cannot be grown on available defined growth culture medium e.g. various mildews and most rust species.
- *Facultative parasites* can grow parasitically on their host as well as by themselves on artificial growth media.

### Predators

- Fungi, which capture and kill other organisms, are called *predators*.
- **Oyster mushroom** (*Pleurotus ostreatus*) is a carnivorous (predator) fungus of nematods.
- Some species of *Arthrobotrys* trap soil nematods by forming constricting ring.
- Predators use animals to fulfill *nitrogen requirements*.

### Mutualists (Symbiotic Association)

- Fungi, which provide benefits to some other organisms and get some other benefits from them are called *mutualists* e.g. lichen and mycorrhizae.
- **Lichen** is symbiotic (mutualistic) association between fungi (mostly Ascomycetes, imperfect fungi and few Basidiomycetes about 20 out of 15000) and certain photoautotrophs (green algae, cyanobacteria or both). Most of the visible part of lichen consists of fungus and algal components are present within the hyphae.
- Lichens are ecologically important as *bioindicators* of air pollution.
- **Crustose** lichen grow tightly attached to rocks, tree trunks, **Foliose** lichen are leaf-like while **Fruticose** lichen are branching.
- **Mycorrhizae** are mutualistic association between certain fungi and roots of vascular plants (about 95% of vascular plants).
- In mycorrhizae, **fungi** increase surface area for absorption and help in direct absorption of phosphorous, zinc, copper and other nutrients from the soil into roots while plant supplies organic food to fungal hyphae.
- There are **two types** of mycorrhizae i.e. endomycorrhizae and ectomycorrhizae.
- In **endomycorrhizae**, fungal hyphae penetrate the outer cells of the plant root forming coils, swellings and minute branches and also extend out into surrounding soil.





- In *ectomycorrhizae*, hyphae surround and extend between the cells but do not penetrate the cell walls of the roots. These are mostly formed with pines, firs etc.

### REPRODUCTION

Most fungi reproduce both sexually and asexually except imperfect fungi, which reproduce only asexually.

#### Asexual Reproduction

- Such type of reproduction, which takes place without fusion of genetic material, is called *asexual reproduction*.
- Different methods** are through spores, conidia, fragmentation and budding.
- Spores** produced inside reproductive structures called sporangia by sexual or asexual processes are haploid, non-motile, small, produced in large amount.
- Conidia** are non-motile, asexual spores, which are cut off at the end of modified hyphae called conidiophores.
- Fragmentation** is simple breaking of mycelium, resulting in formation of a new mycelium from each broken fragment.
- Budding** is an asymmetric division in which tiny outgrowth or bud is produced which may separate and grow. Unicellular yeast reproduce by budding.

#### Sexual Reproduction

- Such type of reproduction, which takes place via fusion of genetic material is called *sexual reproduction*.
- Fusion of nuclei in fungi is called *karyogamy*.
- Fusion of cytoplasm is called *plasmogamy*.
- If karyogamy does not take place immediately after plasmogamy, then the resulting mass of hyphae is called *dikaryotic or heterokaryotic hyphae* cell e.g., as in Basidiomycetes and Ascomycetes.



1. Fungi usually prefer \_\_\_\_\_ habitat.
2. All fungi are multicellular except \_\_\_\_\_.
3. Fungi are \_\_\_\_\_ heterotroph.
4. Saprotrophic fungi have root-like hyphae called \_\_\_\_\_.
5. \_\_\_\_\_ lichen grow tightly attached to rocks.
6. Fusion of nuclei in fungi is called \_\_\_\_\_.

(1) Moist (2) Yeast (3) absorptive (4) Rhizoids (5) Crustose (6) Karyogamy



### CLASSIFICATION OF FUNGI

- Classification of fungi is primarily based on type of their sexual reproductive structures and type of hyphae and some other characters.
- Fungi are classified into four groups.

Phylum (group)	Typical Examples	Sexual Reproduction	Asexual Reproduction	Hyphae
Zygomycota (Zygomycetes or conjugating fungi)	<i>Rhizopus</i> (Black bread mold), <i>Pilobolus</i> (spitting fungus)	Zygospores	Non-motile spores form in sporangia	Non-septate, multinucleate
Ascomycota (Ascomycetes or sac-fungi)	Yeasts, morels, truffles, powdery mildews, molds	Ascospores inside sac-like asci	Conidia cut off from tips of conidiophores	Septate, lengthy dikaryotic phase.
Basidiomycota (Basidiomycetes or club-fungi)	Mushrooms, rusts, smuts, puff balls, bracket fungi	Basidiospores borne on club shaped basidia	Uncommon	Septate, lengthy dikaryotic phase
Deuteromycota (Deuteromycetes/ Imperfect fungi)	<i>Aspergillus</i> , <i>Penicillium</i> , <i>Alternaria</i>	Sexual phase has not been observed	Conidia	Varied

#### ZYGOMYCOTA (ZYGOMYCETES OR CONJUGATING FUNGI)

*Zygospores* are temporary, dormant, thick walled resistant structures formed during sexual reproduction by fusion of hyphae.

#### Life Cycle Of *Rhizopus*

Mycelium > Hyphae (fusion) > Zygote formed by fusion of gametangia > Zygospore > Zygospore germinates > Sporangiphore with sporangis > Meiosis > Spores > New mycelium

#### ASCOMYCOTA (ASCOMYCETES OR SAC - FUNGI)

- It is the **largest group** of fungi.
- There are approximately **60,000 species** of ascomycota, 50% or so occurring in lichen and some are mycorrhizal (e.g. morels).
- Most are **terrestrial** however some are marine or fresh water.
- They reproduce **asexually by conidia** that are often dispersed by wind.
- They also produce haploid sexual spores called **Ascospores**, which are produced in sac-like structures called **asci** (ascus=sac). Commonly 8 ascospores are produced inside each ascus.
- Ascocarps are microscopic fruiting body containing **asci**.



Mycelium > Plasmogamy > Dikaryotic Mycelium > Karyogamy > Zygote (2n) > Meiosis > Mitosis > 8 Ascospores > Mycelium

### Examples

- Yeast, cup fungi and morels are different examples.
- *Yeasts* are unicellular microscopic fungi derived from all the three different groups of fungi but mostly ascomycetes.
- Yeasts reproduce asexually by budding however sexual reproduction by forming asci/ ascospores or basidia/ basidiospores may also occur.
- *Saccharomyces cerevisiae* is the most common yeast.

### BASIDIOMYCOTA ( BASIDIOMYCETES OR CLUB- FUNGI)

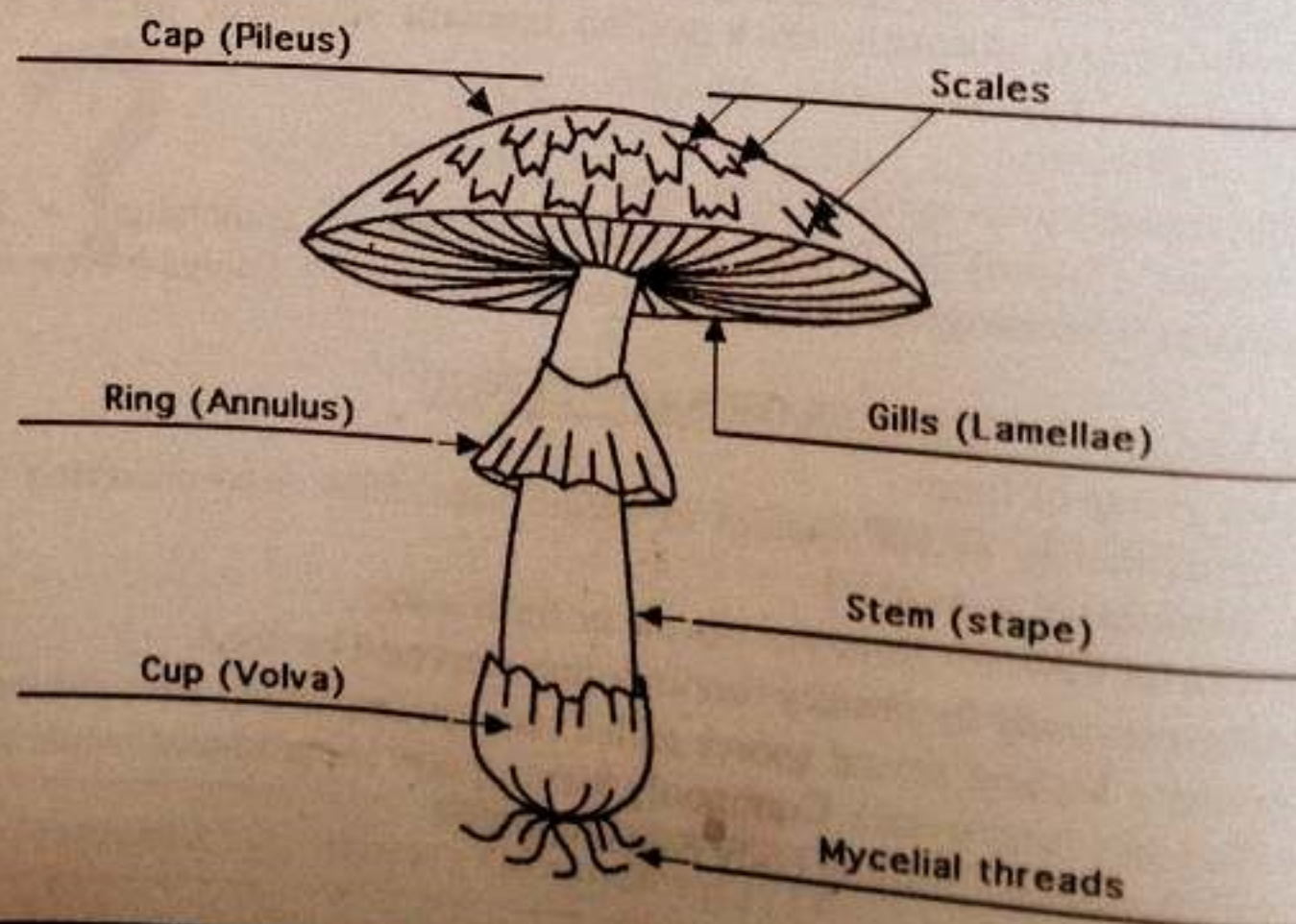
- Named so for their characteristic club shaped sexual reproductive structure, the *basidium*.
- *Basidiospores* are 4 haploid spores which are born on, not inside each basidium.
- Their *hyphae* are septate and cells are uninucleated during one phase and dikaryotic during the remaining.
- Fruiting bodies of basidiomycetes or *visible mushrooms* are formed entirely of dikaryotic mycelium.

Mycelium > Plasmogamy > Dikaryotic Mycelium > Karyogamy > Zygote (2n) > Meiosis > 4 Basidiospores > Mycelium

### Examples

Edible mushrooms, rusts and smuts, puffballs, and bracket/ shelf fungi.

- *Puccinia* species are most common rust fungi.
- *Ustilago* species are most common smut fungi.
- *Rusts* are so called because of numerous rusty, orange yellow coloured disease spots on host surface (mostly stem, leaves).
- *Smuts* are so called because of their black dusty spore masses that resemble soot or smut.
- Spores of *Ustilago tritica* (loose smut of wheat) are called *teliospores*.





**DEUTROMYCOTA (DEUTEROMYCETES OR IMPERFECT FUNGI)**

- All such fungi in which *sexual phase has not been observed* are placed in deuteromycota.
- If sexual structures are found on an imperfect fungus, it is then reassigned to the appropriate phylum.
- Most imperfect fungi are now classified on the basis of *DNA sequences*.
- Imperfect fungi show special kind of genetic recombination called *parasexuality*. In it portions of chromosomes of two nuclei lying in the same hypha are exchanged.

**Examples**

*Penicillium* (blue, green molds), *aspergillus* (brown molds), *Alternaria*, *Fusarium*, *Helmenthosporium*.

**Penicillium**

- Are *saprophytic species*.
- Having *septate hyphae*.
- Reproduce asexually by means of naked spores called *conidia*.
- *Brush like arrangement* of conidia is characteristic of *Penicillium*.

**LAND ADAPTATION OF FUNGI**

- Fungi grow best in *moist habitats*.
- Extensive system of *fast spreading hyphae* increases surface area for absorption.
- *Cytoplasmic flow* throughout the hyphae is responsible for rapid growth and spread of fungi.
- *Chitin* is more resistant to decay than cellulose and lignin.
- *Rhizoids* in saprobes are involved in anchorage, digestion and absorption.
- Lack of flagellated cells, non- motile spores and conidia.
- Fungi *tolerate* in hyperosmotic surrounding (where bacteria cannot survive) and temperature extremes (less than  $-5^{\circ}\text{C}$  to more than  $50^{\circ}\text{C}$ ).

**IMPORTANCE OF FUNGI**

Fungi are important both ecologically and economically.

**Ecological Importance**

- Fungi are important group of *decomposers and symbionts*.
- They play an important role in *recycling of inorganic nutrients* in the ecosystem.
- *Mycorrhizal fungi* improve the growth of plants, with which 95% of vascular plants are associated.
- *Lichen* growing on rocks, break rocks, setting stage for other organisms during the course of ecological succession.
- Lichens being sensitive to pollution are *good indicators* of air pollution.
- Some are also used for *bioremediation*.



## Commercial Importance

## Ecological Gains Due To Fungi

- About 200 species of mushrooms are edible.
- *Morels* (*Morchella esculenta*) and truffles are edible fungi.
- Poisonous mushrooms are called *toadstools* e.g. death cap/death angel (*Amanita*) and Jack O' lantern mushroom.
- *Reindeer moss* (lichen) is used as food for reindeers.
- *Yeasts* are used in production of bread and liquor.
- *Penicillium* species are used for giving flavour, aroma and characteristic colour to some cheese.
- Some species of *Aspergillus* are used for fermenting soya sauce and soya paste from soya bean.
- *Citric acid* is obtained from some *Aspergillus* species.
- *Penicillin* is first antibiotic, which was discovered by A. Fleming in *Penicillium notatum* (fungus).
- *Lovastatin* is used for lowering blood cholesterol.
- *Cyclosporin* is used in organ transplantation for preventing transplant rejection.
- *Ergotin* is used to relieve migraine (one kind of headache).
- *Griseofulvin* is used to inhibit fungal growth.
- *Yeasts* were the first eukaryotes to be used by genetic engineers.
- First functional *artificial chromosome* was made in yeast.
- Pink bread mold *Neurospora* has been used in genetic research.

## Ecological Losses Due To Fungi

- Powdery mildews (on grapes, rose, wheat), ergot of rye, red rot of sugar cane, potato blight, cotton root rot, apple scab and brown rot of peaches, plums, apricots and cherries are common plant diseases caused by fungi.
- *Ringworm* and *athlete's foot* are superficial fungal infections caused by certain imperfect fungi.
- *Candida albicans*, a yeast, causes oral and vaginal thrush (candidiasis or candidosis).
- *Histoplasmosis* is a serious infection of lungs caused by inhaling spores of a fungus, which is common in soil contaminated with bird's feces.
- *Aspergillus fumigatus* causes *aspergillosis* in persons with defective immune system (e.g. AIDS).
- Some strains of *Aspergillus flavus* produce carcinogenic mycotoxins, called *aflatoxins*.
- *Ergotism* is caused by eating purple ergot-contaminated rye flour. It causes nervous spasm, convulsion, psychotic delusion and gangrene.
- 15-50% of world's fruit is lost each year due to fungal attack.
- *Wood-rotting fungi* destroy living trees and structural timber.
- *Bracket/shelf fungi* cause lot of damage to stored cut lumber and timber of living trees.
- A pink yeast *Rhodotorula* grows on shower curtains and other moist surfaces.





1. Fungi are classified into \_\_\_\_\_ main groups.
2. Asexual reproduction is uncommon in \_\_\_\_\_.
3. Black bread mold is common name of \_\_\_\_\_.
4. \_\_\_\_\_ species are most common rust fungi.
5. Most imperfect fungi are now classified on base of \_\_\_\_\_ sequence.
6. \_\_\_\_\_ is most resistant to decay than cellulose and lignin.
7. About \_\_\_\_\_ species of mushrooms are edible.
8. Mycotoxins of *Aspergillus* are \_\_\_\_\_.

### VALUES

Property	Value
Species of fungi	100,000
Number of lichen involving Basidiomycetes	20/15,000
Vascular plants involved in Mycorrhiza	95%
Tolerable pH range of fungi	2-9
Number of species in Ascomycota	60,000
Percentage of Ascomycetes involved in lichen	50%
Number of ascospores in each ascus	8
Temperature range for growth of fungi	-5°C to 50°C
Edible species of mushrooms	200
Annual loss of world's fruit due to fungi	15-50%

Answers: (1) 4 (2) Basidiomycetes (3) *Rhizopus* (4) *Puccinia* (5) DNA (6) Chitin (7) 200 (8) Aflatoxins





## PRACTICE EXERCISE



1. How many species of fungi are known till now?  
 (a) 10,000  
 (b) 100,000  
 (c) 100,00,000  
 (d) 1000
2. Which of the following group represent pathological fungi?  
 A) Mushrooms, morels and truffles  
 (b) Rusts, smuts and molds  
 (c) *Penicillium*.  
 (d) All of these
3. Which one of the following is different from all the rest regarding the number of cells in its body?  
 (a) Rusts  
 (b) Mushrooms  
 (c) Molds  
 (d) Yeasts
4. Fungi, which get their food directly from dead organic matter, are called?  
 (a) Parasitic fungi  
 (b) Predators.  
 (c) Mutualists.  
 (d) Decomposers
5. Root like structure in saprotrophic fungi are called  
 (a) Rhizoids  
 (b) Haustoria  
 (c) Hyphae  
 (d) Constricting rings
6. Those fungi which can grow only on their living host and cannot be grown on available defined growth culture medium e.g. various mildews and most rust species are called  
 (a) Parasitic fungi  
 (b) Obligate parasitic fungi  
 (c) Facultative parasitic fungi  
 (d) All of these
7. *Oyster mushroom* is an example of predator fungi, which attack on  
 (a) Pin worms.  
 (b) Tape worms.  
 (c) Round worms.  
 (d) Plathelminthes.
8. Lichen is a symbiotic mutualistic association of fungi with  
 (a) Autotrophs.  
 (b) Roots of vascular plants  
 (c) Green algae and cyanobacterium.  
 (d) Leguminous plants
9. Foliose lichen are  
 (a) Stem like.  
 (b) Branching.  
 (c) Leaf like.  
 (d) Crust like.
10. An association in which fungal hyphae penetrate the outer cells of the plant root forming coils, swellings and minute branches and also extend out into surrounding soil is called:  
 (a) Mycorrhizal association.  
 (b) Endomycorrhizae  
 (c) Ectomycorrhizae  
 (d) Lichen.
11. The Kingdom of recyclers is known as kingdom  
 (a) Algae  
 (b) Bacteria  
 (c) Fungi  
 (d) Embryophata
12. According to two kingdom classification, fungi were placed in kingdom  
 (a) Plantae  
 (b) Animalia  
 (c) Protista  
 (d) Fungi



13. Ecological role of fungi as decomposers is only paralleled by  
 (a) Cyanobacteria (b) Blue green algae  
 (c) Bacteria (d) Virus
14. Coenocytic hyphae are also known as  
 (a) Septate (b) Perforated hyphae  
 (c) Aseptate (d) Uninucleate hyphae
15. Unicellular fungi which is non-hyphal is  
 (a) Mushroom (b) Yeast  
 (c) *Penicillium* (d) Mold
16. Parasitic fungi absorb nutrients directly from the living host cytoplasm with the help of special hyphal tips called  
 (a) Mildew (b) Constricting ring  
 (c) Haustoria (d) All of these
17. Constricting ring around nematode is formed by  
 (a) *Arthrobotrys* (b) *Pleurotus ostreatus*  
 (c) Mildews (d) All of these
18. Type of lichen which tightly attaches to rocks is  
 (a) *Parmelia* (b) Fruticose  
 (c) Foliose (d) Crustose
19. Mycorrhizae are found in about \_\_\_\_\_ vascular plants.  
 (a) 90% (b) 95%  
 (c) 98% (d) 96%
20. Fungi can tolerate pH from  
 (a) 3-7 (b) 2-6  
 (c) 2-9 (d) 3-6
21. Spores in sporangia are produced by process.  
 (a) Sexual (b) Asexual  
 (c) Both of these (d) None of these
22. Which of the following statement is incorrect about asexual reproduction by spores in fungi?  
 (a) Spores are haploid structures  
 (b) They are dispersed via wind, water and insects.  
 (c) On falling to a suitable place they germinate.  
 (d) These are produced through fruiting bodies like ascocarps & basidiocarps.
23. Simple breaking of mycelium, resulting in formation of a new mycelium from each broken segments is called  
 (a) Sporing. (b) Conidiation.  
 (c) Budding. (d) Fragmentation
24. By which of the following mechanism unicellular yeast reproduce?  
 (a) Sporing. (b) Conidiation.  
 (c) Budding. (d) Fragmentation
25. In which of the following example of fungi dikaryotic hyphae exist for long period?  
 (a) Deuteromycota (b) Basidiomycota  
 (c) Zygomycota (d) All of these
26. Which of the following is called black bread mold?  
 (a) *Pilobolus* (b) *Penicillium*  
 (c) *Neurospora* (d) *Rhizopus*





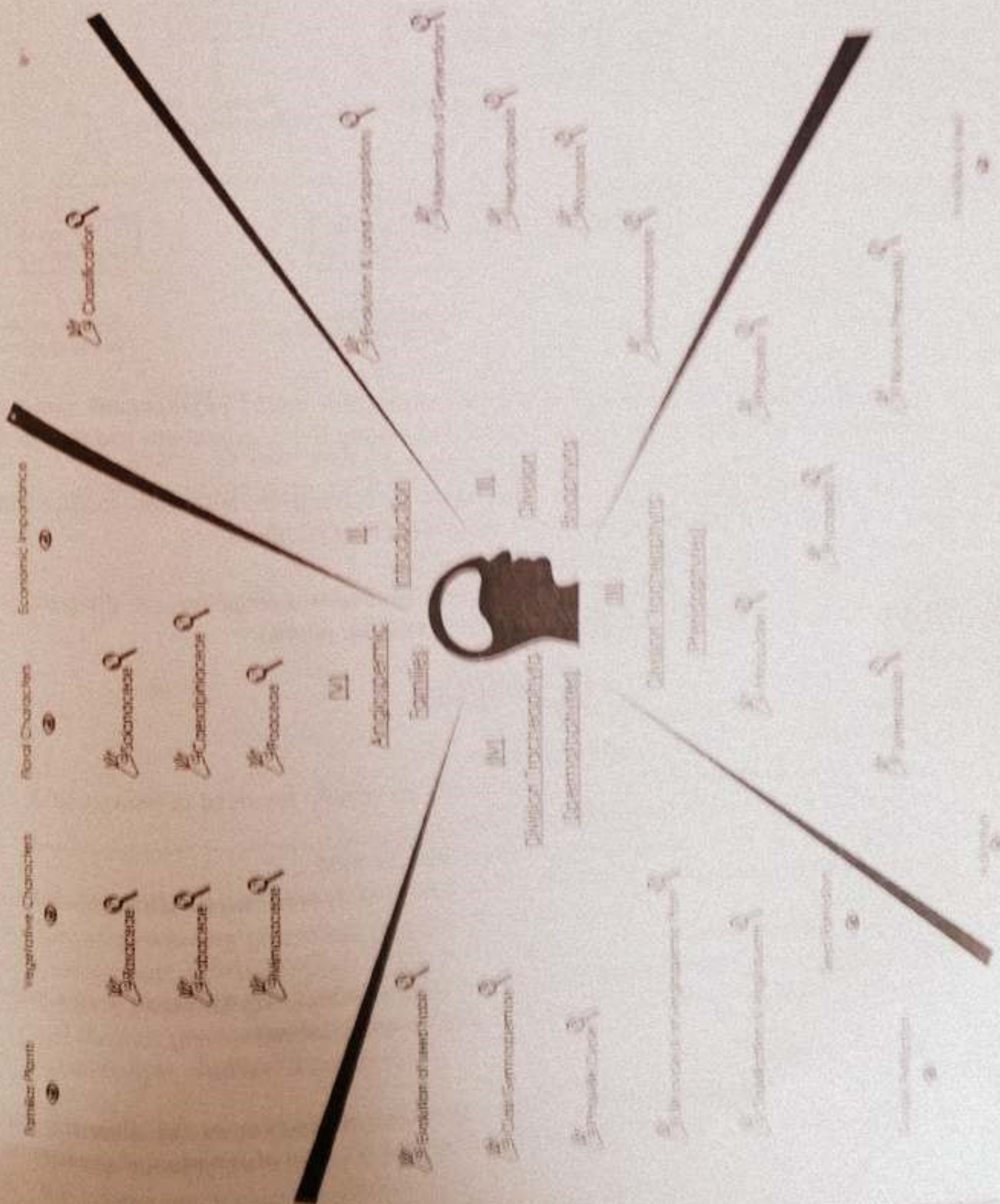
27. At which stage in the life cycle of *Rhizopus* meiosis takes place?  
 (a) Formation of sporangiophore via germination of zygosporangium.  
 (b) Formation of spores in sporangia  
 (c) Fusion of two hyphae  
 (d) Formation of Zygote by fusion of gametangia.
28. Which one of the following is the largest group of fungi?  
 (a) Zygomycota. (b) Ascomycota.  
 (c) Basidiomycota. (d) Deuteromycota.
29. How many species of ascomycota occur in lichen symbiotic association?  
 (a) 30 % (b) 40 %  
 (c) 50 % (d) 60 %
30. All such fungi in which sexual phase has not been observed are present in  
 (a) Zygomycota. (b) Ascomycota.  
 (c) Basidiomycota. (d) Deuteromycota
31. Mode of nutrition in *penicillium* is  
 (a) Saprotrophs. (b) Parasitic.  
 (c) Predators. (d) Mutualistics.
32. *Penicillium* reproduce via  
 (a) Spores. (b) Conidia.  
 (c) Budding (d) Fragmentation
33. How many species of mushrooms are edible?  
 (a) 100 (b) 200  
 (c) 3000 (d) 4000
34. Death cap/death angel (*Amanita*) and Jack O' Lantern mushroom are examples of  
 (a) Edible mushrooms.  
 (b) Poisonous mushrooms.  
 (c) Both of these.  
 (d) None of these



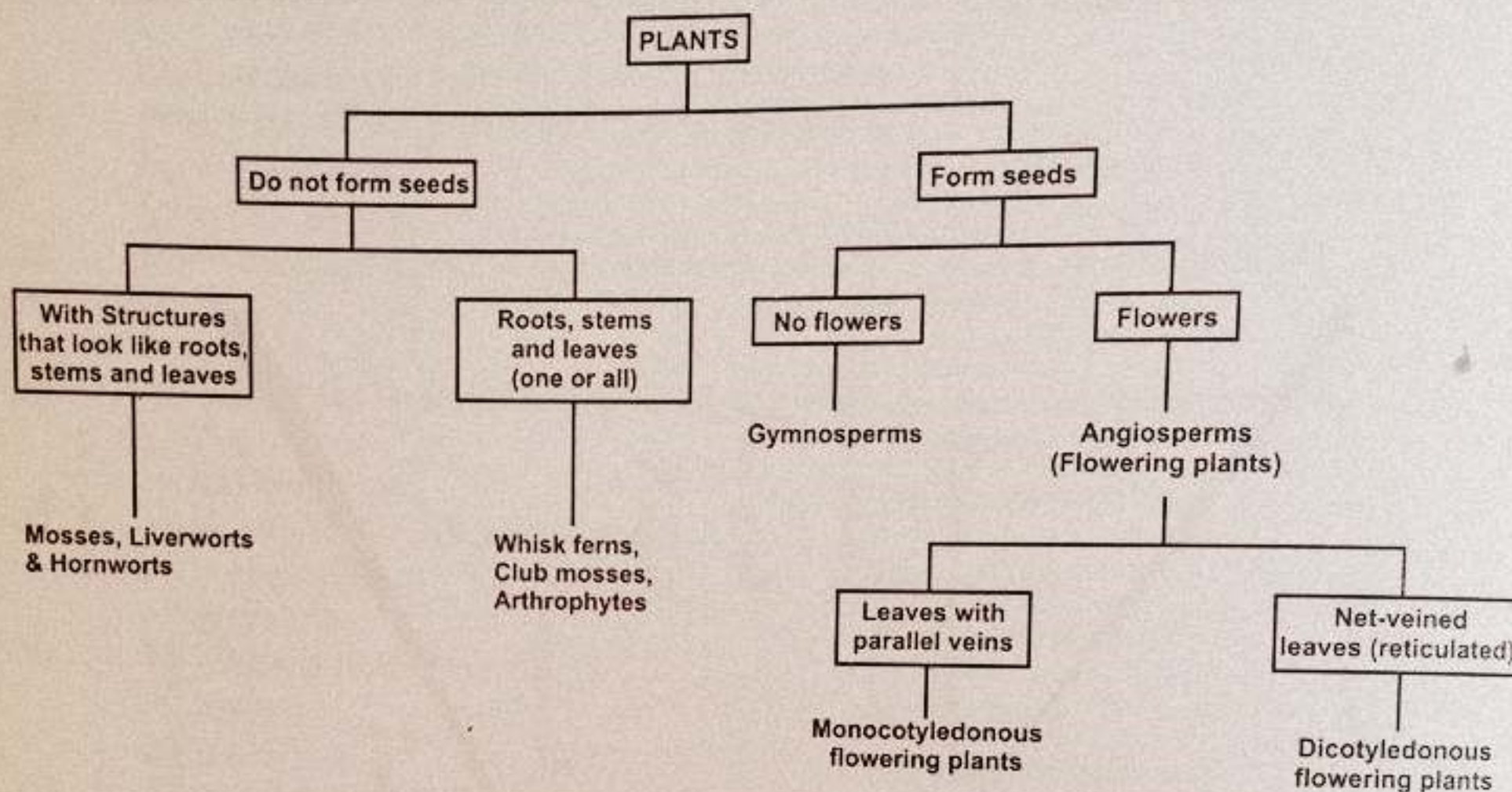


# Chapter 9

## KINGDOM PLANTAE





CLASSIFICATION OF KINGDOM PLANTAE

- Arrangement of organisms on base of their mode of origin is called *phylogenetic system of classification*. It foreshadows the natural relationship among living organisms and their mode of origin.
- **Kingdom plantae** mainly includes organisms, which are eukaryotic, autotroph, multicellular, non-motile, develop from embryo and have cell wall made of cellulose.
- There are about **360,000** known species of plants.
- Kingdom Plantae can be broadly divided into **two major categories** or divisions i.e. **bryophyta** (non-vascular plants) & **tracheophyta** (vascular plants).

**BRYOPHYTA**

- They are the **first plant to colonize land**.
- They are thought to be **evolved from green algae**.
- **Vascular system is absent**. So osmosis and diffusion are mainly involved in transportation.
- **Gametophyte** generation is **dominant**
- **Sporophyte** is attached to gametophyte and dependent for food.
- They are **homosporous**, poorly adapted to life on land, mainly confined to damp and shady places.
- They are **flowerless** plants.
- They show a **regular alternation of heteromorphic** (morphologically different) generations.
- They require water for fertilization thus called **amphibians of plants**.

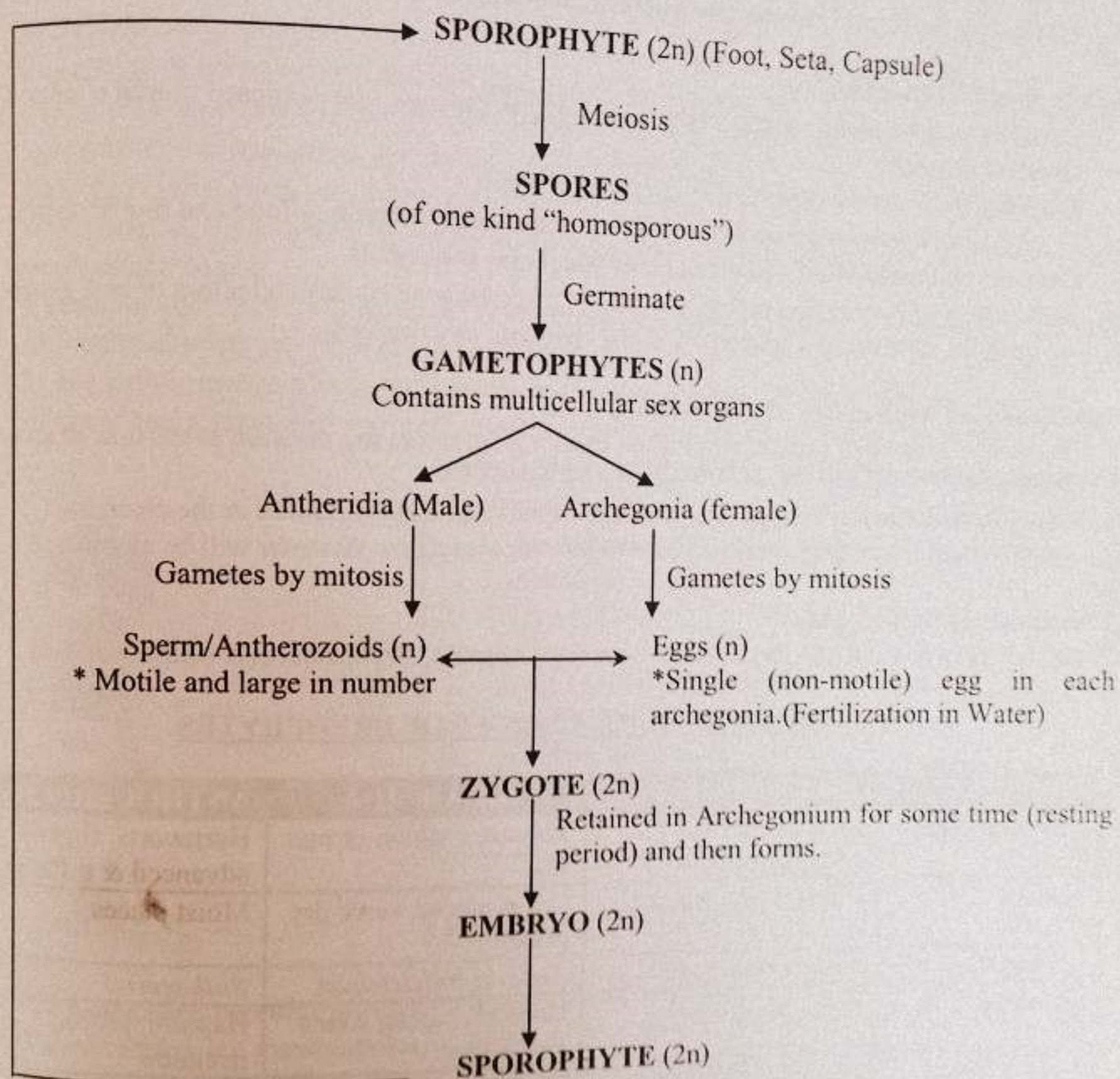
**Alternation of Generation**

- Process in which one multicellular, haploid gametophyte generation (n) alternates with another multicellular, diploid sporophyte generation (2n) is called **alternation of generations**.



- Alternation of morphologically different generations is called *heteromorphic alternation of generation* while that of morphologically similar generations is called *homomorphic alternation of generation*.
- Bryophytes show heteromorphic alternation of generation.

### Life Cycle of Bryophytes



### Gametophyte Generation (n)

- *Gamete producing* generation is called gametophyte.
- Gametophyte of bryophytes is **dominant**, independent, free living and is haploid.
- It may be **thalloid** (as in many liverworts) **or differentiated** into structures like stem, leaves and rhizoids (anchoring and absorbing organ).
- Gametophyte produces a sporophyte.

### Sporophyte Generation (2n)

- *Spore producing* generation is called sporophyte.
- It is a **less conspicuous** generation.



- It does not contain chlorophyll and is unable to perform photosynthesis, thus are partially or totally dependent on gametophyte for their nutrition.
- It is a **diploid** generation.
- It consists of **foot, seta and capsule**.
- Entire sporophyte development takes place in gametophyte.
- When fully developed remain attached to gametophyte to get nourishment from it.

### Adaptation To Land Habitat

- Compact multicellular plant body and cuticle reduces the exposed surface area thus **conserving water**.
- **Photosynthetic tissue** is present in special chambers.
- They exhibit **heterogamy** consisting of non-motile egg containing food and motile sperms.
- Gametes and embryo are **protected** by multicellular sex organs.
- **Alternation of generation** provides a chance of genetic variability, selection of best genetic makeup for survival and adaptation in the changing environment.

### Significance of Alternation of Generations

- Provides a chance of genetic variability, resulting from meiotic division at the time of spore formation.
- Result in selection of best genetic makeup for survival and adaptation in the changing environment. Thus the gametophyte with less advantageous character will be eliminated.

### Classification Of Bryophytes

Bryophytes are divided into three classes i.e. Hepaticopsida, Bryopsida, and Anthocercopsida.

### FEATURES OF THREE CLASSES OF BRYOPHYTES

FEATURE	HEPATICOPSIDA	BRYOPSIDA	ANTHOCERPCIDA
<b>Introduction</b>	Liverworts, 900 species, simplest	Mosses, cushion or mat like	Hornworts, slightly advanced & different.
<b>Habitat</b>	Moist rocks, wet soil	Damp places, some dry places	Moist places
<b>Examples</b>	<i>Marchantia, Porella</i>	<i>Funaria, Polytrichum</i>	<i>Anthoceros</i>
<b>Gametophyte</b>	Haploid, thalloid	Haploid, having stems and leaves.	Haploid, lobed, irregular
<b>Sporophyte</b>	Diploid, dependent	Diploid	Free, independent

#### Hepaticopsida

- **Thallus** of liverworts is flat or ribbon-like usually dichotomously branched.
- Some liverworts are attached to soil by **rhizoids** (*Marchantia*) others are falsely leafy (*Porella*).
- In liverworts **sex organs** develop on tip of thallus (*Porella*) or on special branches (*Marchantia*) which are antheridiophore and archegoniophore.

#### Bryopsida

- Archegonia and antheridia of mosses develop on different branches of same plants (*Funaria*) or on different plants (*Polytrichum*).





- In mosses, archegonia and antheridia form clusters and are mixed with sterile hair forming a structure called **paraphyses**.
- Spore of a moss, unlike of liverworts, develop into an alga-like structure called **protonema**.
- Protonema produces a bud from which a haploid moss plant (gametophyte) is formed.

### Anthoceropsida

- **Antheridia and archegonia** in hornworts are partially *sunken* in gametophyte.
- Sporophyte of hornworts is **advance** than that of liverworts and mosses.
- It is initially dependent on gametophyte then becomes independent.
- Sporophyte of anthocerotae has **stomata and chloroplast**.
- They also have a **waxy cuticle** to check excessive loss of water.
- In sporophyte of hornworts, at junction of foot and spore producing region, there is a band of **meristematic tissue**,
- It keeps on adding cells towards the spore producing region during the formation, maturation and dispersal of spores from the opposite end.
- Its fast growth rate results in increase in length of sporophyte for indefinite period of time.
- All these characters make sporophyte survive even after the death and decay of gametophyte.



1. There are about \_\_\_\_\_ known species of plants.
2. Gametophyte in plants produces \_\_\_\_\_ generation.
3. There are about \_\_\_\_\_ known species of liverworts.
4. Some liverworts are attached to soil by \_\_\_\_\_.
5. *Anthocerus* is an example of \_\_\_\_\_.
6. In plants, gametes are produced by \_\_\_\_\_.

### TRACHEOPHYTES

- They are called **vascular plants** due to presence of vascular tissue xylem and phloem.
- Tracheophytes are **most successful plants** of land habitat due to presence of roots, stems, leaves, vascular tissue, flowers, fruits, seed formation, pollen tube and heteromorphic alternation of generations.

### Division Of Tracheophytes

Tracheophytes are further subdivided into **four sub-divisions** i.e.

- Psilopsida
- Lycopsidea
- Sphenopsida
- Pteropsida.

Answers: (1) 360,000 (2) Sporophyte (3) 900 (4) Rhizoids (5) Anthoceropsida (6) Mitosis





## Features Of Groups Of Tracheophytes

Feature	Psilopsida	Lycopsida	Sphenopsida
Introduction	Psilophyta, earliest group	Club moss, spike moss (due to club/spike shaped strobili), ground pries	Horsetails, arthrophytes
Sporophyte	Diploid, dominant, rootless, rhizome with rhizoids, leafless	Diploid, dominant, differentiated root, stem & leaves	Diploid, dominant, differentiated root, stem & leaves
Gametophyte	Thalloid, colourless, underground, haploid, reduced, with mycorrhizal association	Haploid, reduced, underground	Thalloid, growing on clayed soil & mud
Examples	Fossils are <i>Rhynia</i> , <i>Horneophyton</i> , <i>Psilophyton</i> , <i>Cooksonia</i> . Living members are <i>Psilotum</i> , <i>Tmesipeteris</i>	<i>Lycopodium</i> , <i>Selaginella</i>	<i>Equisetum</i>

## PSILOPSIDA

## Sporophyte (2n)

- *Stem* of sporophyte of psilopsids is differentiated into an *underground rhizome* and an *aerial part*, both are dichotomously branched.
- Aerial branches of psilopsid sporophyte are green, leafless and bear small veinless outgrowths.
- *Sporangia* are reproductive organ of psilopsida.
- *Internal structure of stem* is simple. Vascular tissue is narrow, central and solid without path. Cortex is wide.

## Gametophyte (n)

- It is thalloid, colorless and underground.
- It develops *mycorrhizal association* with a fungus. This symbiotic relation gives food to the gametophyte, while the fungus in return gets protection from it.

EVOLUTION OF LEAF

- Leaf is *photosynthetic organ* of plant.
- Primitive vascular plants were without leaves containing *dichotomously branching* *naked stem* without leaves.
- Initially small *scale like outgrowth* formed on these naked stems, without any vascular bundle which were not true leaves.
- *Lycopods* are the first to have true leaves with one single undivided vein.
- There are *two types of leaves* i.e. microphylls and megaphylls.
- *Microphylls* are small with single undivided vein (vascular bundle).



- Megaphylls are large leaves with *divided veins and veinlets* with expanded leaf blade or lamina.
- Megaphylls are present in *ferns and seed plants*.
- *Evolution* of megaphylls *started* from a dichotomous branching system in some primitive fern-like plants approximately *350 million years* ago.
- Evolution of megaphylls was *completed* in *15-20 million years*.
- *Three steps* are considered in evolution of megaphylls i.e. overtopping, planation and fusion/webbing.
- *Overtopping* is an unequal development of various branches.
- *Planation* is arrangement of unequal dichotomous branches in one plane.
- *Fusion/webbing* is development of photosynthetic tissue between branches, which itself converted into veins.
- Major function of leaves is increase in absorptive area of light.

### LYCOPSIDS

They are also called :

- *Ground pries* because of their slight resemblance to evergreen plants.
- *Club mosses/ spike mosses* because of their club/ spike shaped strobili and small leaves resembling mosses.

### Sporophyte (2n)

- Sporophyte of lycopsida differentiates into roots, stem and true leaves.
- Leaves are *microphylls* i.e. small and single veined, arranged spirally or opposite.
- *Sporangia* develop singly on the upper side of sporophylls.
- Sporangia may be of one kind as in *lycopodium* or of two kinds i.e., microsporangia & megasporangia as in *selaginella*.
- Club shaped structure formed from clustering of sporophylls at the tips of branches are called *strobili*.
- Those sporophytes, which only produce one type of spores are called *homosporous*, while those producing spores of two types are called *heterosporous*, and this condition is called homospory and heterospory.
- Some lycopods like *selaginella* have a leaf-like structure called *ligule* (an outgrowth present on the upper side of the sporophylls near their base).

### Gametophyte (n)

Their gametophyte is usually underground.

### Lycopodium And Selaginella

Feature	Lycopodium	Selaginella
Sporangia	One kind	Two kinds i.e. microsporangia & megasporangia
Strobili (cone)	Absent	Present
Spores	One type (homosporous)	Two types i.e. microspores & megaspores, thus resembles seed producing plants (spermatophyte)



		because of its heterosporic conditions.
Ligule	No ligule	Ligule is present

### SPHENOPSIDA

They are also called *arthrophytes* because the whole plant body is composed of large number of joints.

#### Sporophyte (2n)

- Their *sporophyte* is differentiated into root, stem and leaves.
- *Leaves* are expanded or scale like, arranged in whorls.
- *Main stem* is not smooth instead it contains ridges and furrows.
- *Sporangia* are produced on sporangiophores and are aggregated to form *strobili*.
- Each *sporangiophore* has a slender stalk and an expanded disc at its free end. Sporangia appear on the underside of the disc.

#### Gametophyte (n)

It is a thalloid and grown upon clayey soil and on mud.

### PTEROPSIDA

This group is divided into *three classes* i.e. filicineae, gymnospermae and angiospermae.

#### FILICINAE

- Plants present in class filicineae are called *ferns*.
- Ferns are seedless plants.
- Their leaves are called *fronds*.
- *Circinate vernation* is a pattern of development of fronds, such that when they are immature and young they are coiled.
- They are *worldwide in distribution*, abundant in tropics
- They are *shade and moisture loving plants*.
- Some are *epiphytic* (growing on bark of trees)
- *Examples* of ferns are *Dryopteris*, *Pteridium*, *Adiantum* and *Pteris*.



1. In cut section of stem of Psilopsida, \_\_\_\_\_ is absent.
2. \_\_\_\_\_ are the first plants to have true leaves.
3. Megaphylls are present in ferns and \_\_\_\_\_ plants.
4. \_\_\_\_\_ are also called arthrophytes.
5. Plants present in filicinae are called \_\_\_\_\_.
6. *Pteris* is an example of \_\_\_\_\_.

(1) Pith (2) Lycopods (3) Seed (4) Sphenopsids (5) Ferns (6) Ferns



Adiantum (*Maiden hairfern*) is most common example of fern, which grows at along moist walls, water courses and drains.

### Structure

- It is small **herb** consisting of stem, roots and leaves
- **Stem** is short, thick, underground, usually branched, horizontally growing rhizome
- **Rhizome** is protected by brownish scales called **ramenta** and covered by persistent leaf bases
- Fibrous **adventitious roots** arise from the lower side of rhizome.
- Compound leaves or **fronds** arise from upper side of rhizome
- Young leaves show **circinate vernation**.
- **Stipe** (stalk) and **rachis** of leaf are black, smooth and shiny (hence called maiden hair fern)
- Leaflets show **dichotomous venation**.
- Leaflets are **pinnae** (first order) and **pinnules** (second order)
- **Sori** (group of sporangia) are born on the underside of reflexed lobes of the margins on leaflets and are protected by bent margins of the leaflets forming **false indusium**.

### Alternation Of Generation

- Adiantum shows **heteromorphic alternation of generation**.
- **Sporophyte** is **dominant** while **gametophyte** is small, **reduced** but separate and independent.

### Structure Of Sporophyte

- It is **diploid**.
- It produces **number of sori** (groups of sporangia), which are first green and then become dark brown after ripening.
- Each **sorus** consists of a number of sporangia covered by false indusium.
- Leaves bearing sporangia are called **sporophylls**.
- Each **sporangium** is slightly flattened, biconvex, born on multicellular stalk.
- **Capsular wall** is made of single layer of flat cells.
- Edge of capsule is made of two parts i.e. annulus and stomium.
- **Annulus** occupies  $\frac{3}{4}$ <sup>th</sup> of edge and its cells have radial and inner walls thickened.
- **Stomium** occupies  $\frac{1}{4}$ <sup>th</sup> of the edge and its walls are thin

### Structure Of Gametophyte

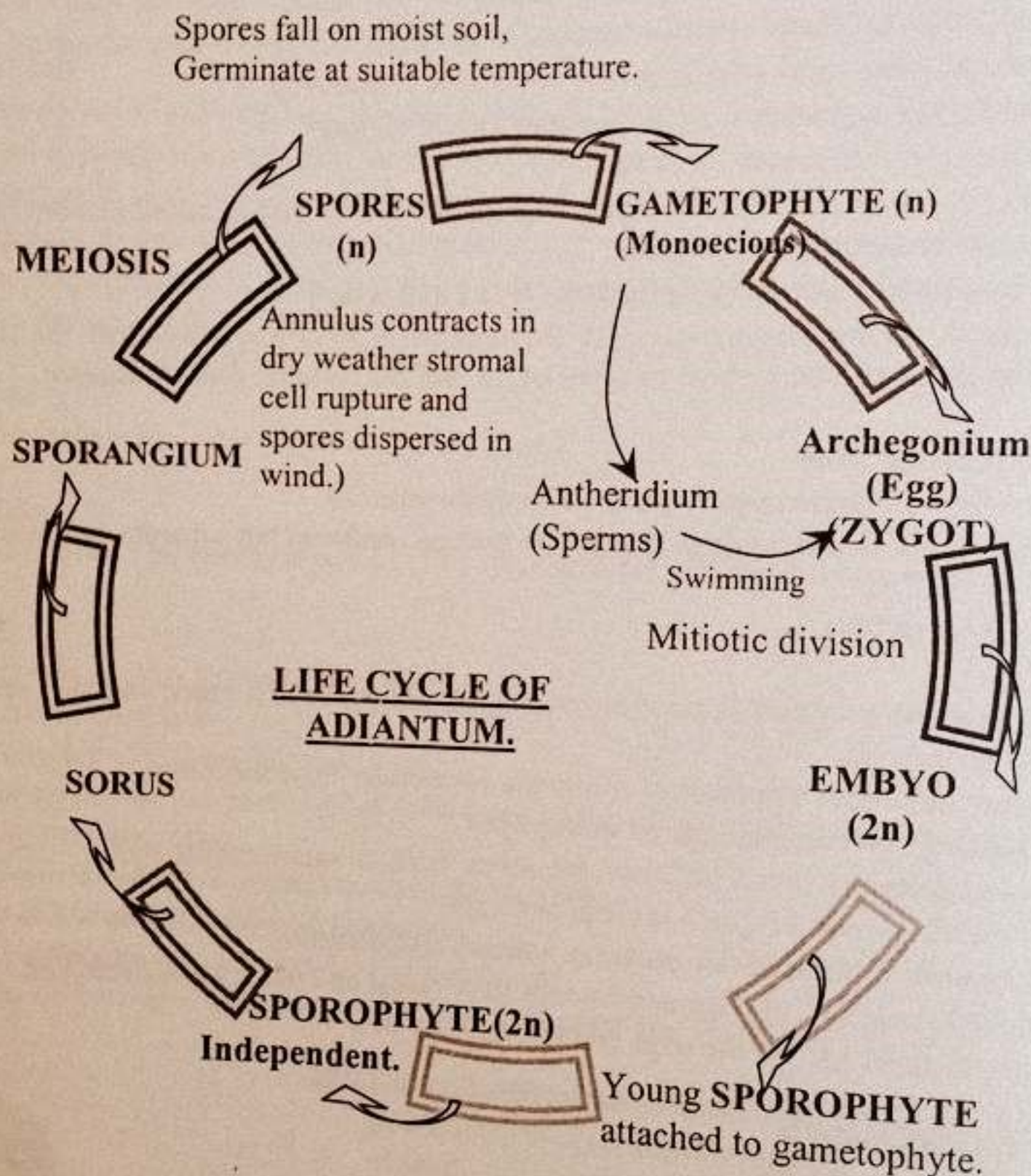
- It is also called **prothallus**.
- It is **autotrophic**, small, flat, and heart-shaped.
- At anterior end there is notch where **growing point** is present.
- Its **size** is about one-third of an inch at its longest diameter. (8 mm)
- It is **horizontally placed** in soil.
- **Unicellular rhizoids** are present on its lower surface towards posterior end. These fix prothallus to the soil and absorb nutrients.
- It is composed of rounded, thin walled cells.
- **Margins of prothallus** are one-celled thick but middle part is many-cell thick and is cushion like.





- It is *monoecious* i.e. male and female sex organs appear on the underside of the same prothallus.
- In mature prothallus, archegonia occur near the notch and antheridia are scattered among rhizoids.
- Archegonia consist of a *venter* and a *neck*.
- *Venter* contains the egg or oosphere and is embedded in the cushion of the thallus

### Life Cycle



- All the seed producing plants are called *spermatophytes*.
- *Seed* is a fertilized ovule.
- An *ovule* is an integumented indehiscent megasporangium.
- *Integuments* are specialized protective coverings around megasporangium, which vary in number.
- Development of seed started about 390 million years ago.



- First complete seed appeared approximately 365 million years ago during late Devonian period.

### Various Steps Involved in the Evolution of Seed Habit

#### Evolution of Heterospory

- Production of one kind of spores is called *homospory* and plants homosporous.
- All groups of land plants up to pteridophytes are homosporous.
- **Heterospory** is production of two types of spores i.e. smaller microspores (from microsporangia) and larger megaspores (from megasporangium).
- Microspore converts into microgametophyte (male gametophyte) and megaspore convert into megagametophyte (female gametophyte).

#### Retention and Germination of Megaspore Within the Megasporangium

- In the heterosporous vascular plants, the megaspores are usually to be shed and dispersed.
- In some plants (e.g. *selaginella*) the megaspore is not allowed to escape from megasporangium immediately after its formation.
- In others the megaspore is permanently retained within megasporangium.

#### Development of Protective Layers Around Megasporangium

- **Integument** are the protective coverings around megasporangium derived from branch like structures of sporophytes.
- These integuments result in formation of ovule, a well protected egg containing apparatus in terrestrial environment.

#### Reduction to a Single Functional Megaspore Per Sporangium

- Each megaspore mother cell within a megasporangium produces four megaspores in between which there is competition for space and food.
- Vascular plants adopted a new strategy of selection of only one megaspore per megasporangium for further development into healthy female gametophyte.

#### Development of an Embryo Sac Within the Sporangium

One selected megaspore germinates to form an egg containing female gametophyte called an embryo sac.

#### Modification of Distal End of Megasporangium For Pollen Capture and Development of Pollen Tube

Pollen after being captured, produces pollen tube to carry male gametes deep to the embryo sac to fertilize the egg.

#### Formation of Seed and Seed Coats

- Megasporangium (ovule) after fertilization is transformed into *seed*.
- Integuments are converted into *seed coats*.

### GYMNOSPERMS

- These are *heterosporous plants* which produce seeds but no fruit.
- They are *worldwide in distribution*, one of successful group of land plants,  $1/3^{\text{rd}}$  of total world's forest.
- 'Gymno' means 'naked' and 'spermae' means 'seeded' so they are naked seeded plants.
- **Naked ovules** are born on exposed surface of megasporophylls, which unlike those of angiosperms are not enclosed in fruit but lie naked on the surface of fertile leaves.
- **Different genera** of gymnosperms are: *Cycas* (sago-palm), *Pinus* (pines), *Taxus* (yew), *Picea* (hemlock), *Cedrus* (deodar), *Ginkgo* etc.

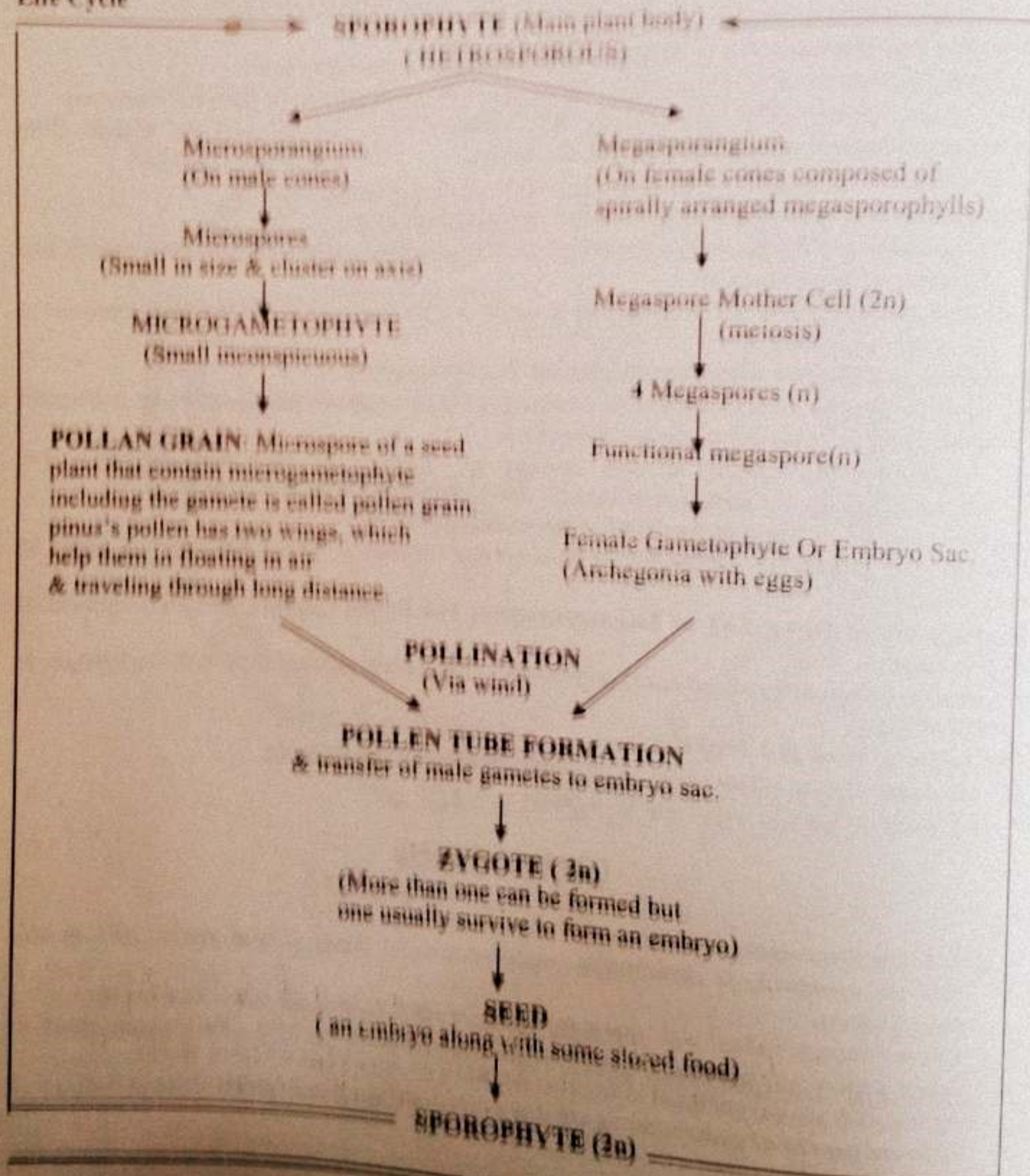


## Chapter 9

## Alternation of Generation

- They show *regular heteromorphic* alternation of generation.
- Independent, dominant sporophyte and less conspicuous, dependent gametophyte is present.
- *Microsporophylls* produce microspores and *megasporophylls* produce megaspores.
- Female gametophytes always remains in ovule.
- The megasporophylls bearing ovules are not folded and joined at the margins to form an ovary for this reason seeds lie naked on the megasporophylls.

## Life Cycle

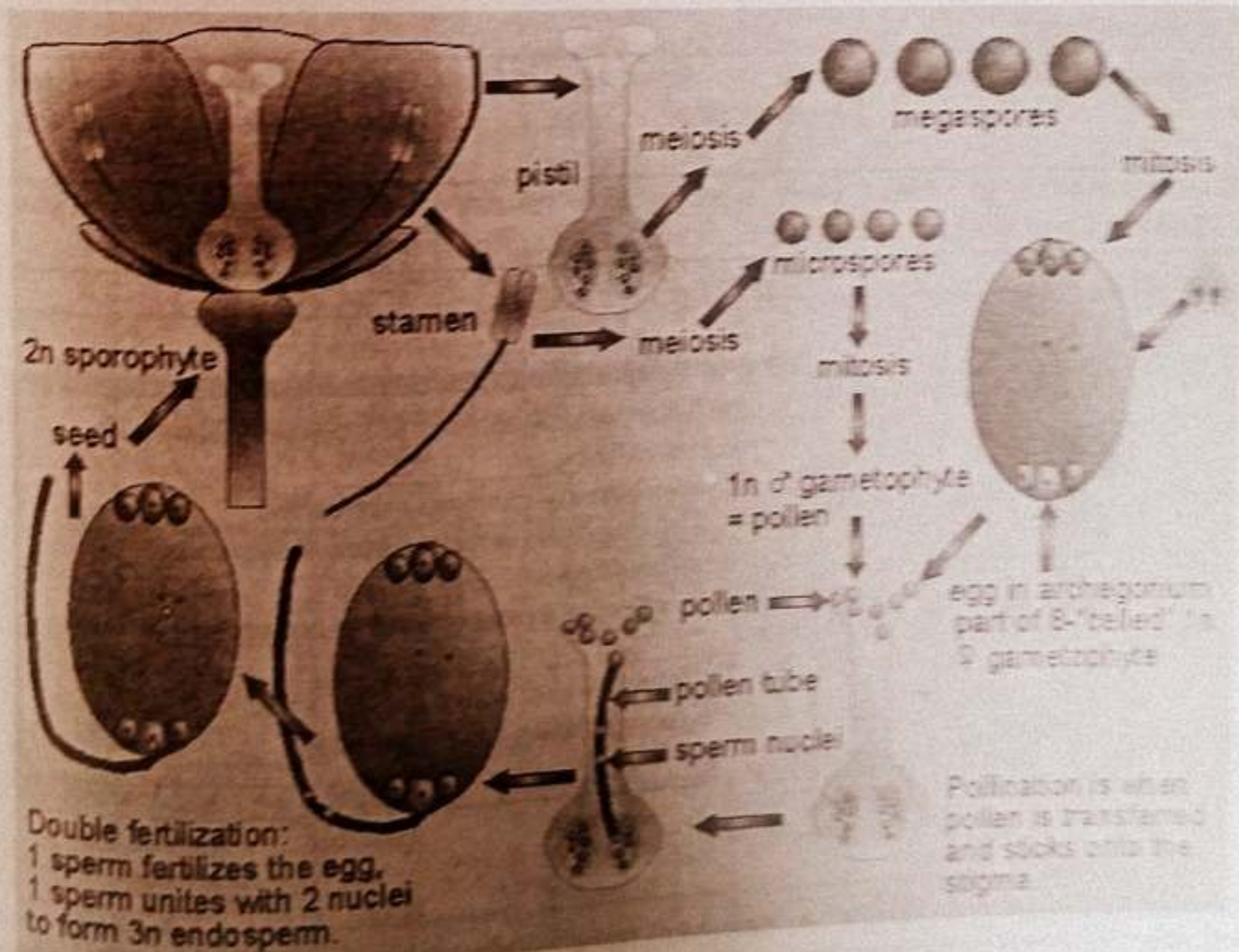




- They are *heterosporous autotrophic plants* which produce flowers, fruits and seeds.
- 'Angio' means 'close' and 'sperm' means 'seed'.
- Most abundant of land plants, **235,000 species** out of 360,000 plant species.
- A **flower** is a modified shoot, which consists of a pedicel, **thalamus (torus)** and floral leaves (sepals, petals, stamens and carpals).
- Thalamus, stamens and carpals are **modified leaves**.
- Sepals and petals are **non-essential** or non-reproductive parts.
- **Sepals** protect the inner parts.
- **Petals** attract insects for pollination.
- Sepals and petals fall off after pollination.
- Stamens and carpals are **essential** or reproductive parts of flower.
- **Stamen** consists of a filament and anther. It is male reproductive part of flower.
- **Carpal** consists of ovary (basal broader part), style and stigma (terminal part of style). It is female reproductive part of flower.

#### Alternation of Generation & Life Cycle

- Angiosperms exhibit **heteromorphic alternation of generation** in which dominant diploid sporophyte generation alternates with inconspicuous gametophyte generation.
- **Main plant is diploid sporophyte** differentiating into roots, stems and leaves. At maturity flowers are also formed.





**Seed Formation**

- **Testa & tegmen** are coverings of seed that develop from integuments of the ovule
- **Fruit** is formed from the ovary wall.
- Seed under suitable conditions **germinates** and produces a seedling which gradually changes into sporophyte.

**CLASIFICATION OF ANGIOSPREMS**

On the basis of number of cotyledons in the embryo, angiosperms are divided into two classes i.e.

- Monocotyledonae (monocot)
- Dicotyledonae (dicot).

**MONOCOT AND DICOT**

DIFFERENCE	MONOCOT	DICOT
Number of cotyledons	One cotyledon	Two cotyledon
Number of sepals and petals	3 or multiple of 3	4 or 5 or multiple of 4 or 5
Arrangement of vascular bundle in stem	Bundles scattered	Bundles in a ring
Pattern of veins	Parallel veins	Net veins
Presence or absence of wood	All herbaceous	Both herbaceous and woody
Symmetry of accessory parts of the flower:	Both regular & irregular	Both regular & irregular
Individual or united petals:	Both separate and gamopetalous	Both separate and gamopetalous
Relative position of male and female flower parts:	Both superior and inferior ovaries	Both superior and inferior ovaries
Examples	Wheat, rice, maize	Gram, pea



1. In Adiantum, rhizome is protected by brownish scales called \_\_\_\_\_.
2. Leaves bearing sporangia are called \_\_\_\_\_.
3. \_\_\_\_\_ is an integumented indehiscent megasporangium.
4. Pollination in gymnosperms is commonly through \_\_\_\_\_.
5. Thalamus is also called as \_\_\_\_\_.
6. Vascular bundles are scattered in \_\_\_\_\_.

Answers: (1) Ramenta (2) Sporophylls (3) Ovule (4) Wind (5) Torus (6) Monocots



Feature	Rosaceae	Solanaceae	Fabaceae	Caesalpiniaceae	Mimosa ceae	Poaceae
INTRODUCTION						
Common name	Rose family	Potato family	Pea or papilionaceae family	Cassia family	Acacia or mimosa family	Gramin ae or Grass family
Total genera	100	90	400	152	56	600
Total species	2000	2000	9000	2300	2800	10,000
Genera in Pakistan	29	14	82	16	11 (4 native)	158
Species in Pakistan	213	52	587	60	49 (18 native)	492
STRUCTURE						
Familiar plants	<i>Pyrus</i> (pear), <i>Rosa</i> (rose), <i>Malus</i> (apple), <i>Fragaria</i> (strawberry)	<i>Solanum tuberosum</i> (potato), <i>Nicotiana tobacum</i> (tobacco), <i>Lycopersicu m esculentum</i> (tomato), <i>Capsicum frutescens</i> (red pepper), <i>Capsicum annuum</i> (pepper)	<i>Lathyrus odoratus</i> (sweet pea), <i>Arachis hypogaea</i> (peanut), <i>Cicer arietum</i> (chick pea), <i>Dalbergia sisso</i> (shisham)	<i>Tamarindus indica</i> (tamarind), <i>Cassia fistula</i> (amaltas), <i>Bauhinia veriegata</i> (kachnar)	<i>Acacia nilotica</i> , <i>Albizia lebbek</i> , <i>Mimosa pudica</i> (touch me not), <i>Prosopis glandulosa</i> , <i>P. Cineraria</i>	<i>Triticum vulgare</i> (wheat), <i>Zea mays</i> (corn), <i>Avena sativa</i> (oat), <i>Oryza sativa</i> (rice), <i>Bambusa</i> (bamboo), <i>Saccharum officinarum</i> (sugar cane)
Plants	Trees, shrubs, herbs	Herbs, shrubs, trees, vines	Herbs, shrubs, trees	Trees, shrubs, woody climbers, rarely herbs	Trees, shrubs, rarely climbers, herbs, most xerophytes	Annual or perennial herbs
Stem	Shrubby having spines	Hairy or prickly	Herbaceous or woody or climber by tendrils	Erect, woody, herbaceous or climbing	Woody	Jointed, hollow at internodes and closed at nodes





<b>Leaves</b>	Alternate, rarely opposite, simple or compound with paired stipules, spines on rachis	Alternate or rarely opposite, simple, petiolate, rarely sessile <i>without pedicel</i>	Compound or rarely simple, sometimes tendrils, alternate, stipulate, stipules leafy	Compound, pinnate, rarely simple and stipulate	Compound, pinnate, alternate, stipulate, stipules modified into thorns	Solitary at nodes, sometimes crowded at base, alternate, exstipulate, ligulate, mostly sessile, simple
<b>Inflorescence</b>	Variable, solitary. May be racemose or cymose	Axillary cyme or combination of cymes, sometimes helicoids or axillary umbellate cyme	Racemose or solitary, axillary	Axillary or terminal raceme or panicle or spikes, rarely cymose, showy	Spike-like or head or umbel, rarely racemose or globos umbels	Compound, composed of units called spikelets
<b>Flower</b>	Bisexual, actinomorphic, often <u>perigynous</u> , showy, scented	Bisexual, usually actinomorphic, weakly zygomorphic, <u>hypogynous</u> , pentamerous	Bisexual, zygomorphic, bracteate, pedicellate, <u>perigynous</u> , pentamerous, papilionaceous	Bisexual, zygomorphic, rarely actinomorphic, <u>perigynous</u>	Bisexual, actinomorphic, <u>hypogynous</u> to slightly <u>perigynous</u> , bracteate	Bisexual, sometime unisexual, small, inconspicuous, sessile, bracteate, incomplete, zygomorphic, <u>hypogynous</u>
<b>Calyx</b>	5 sepals, rarely 4, united at base	5 united sepals, usually persistent	5 sepals, united in a tube, hairy	5 sepals, free or connected at base, often coloured	5 sepals, generally fused, toothed or lobed	Perianth absent or represented by 2, rarely 3 lodicules
<b>Corolla</b>	5 petals or multiple, free, rosaceous, large, showy	5 united petals, rotate to tubular	5 petals, papilionaceous, clawed, dissimilar: standard, wing, keel	5 petals, free	5 petals, free or fused and lobed	(As Above)
<b>Androecium</b>	Numerous, sometimes 5 or 10	5 stamen rarely 4, free, epipetalous, didynamous	10 stamens, diadelphous (9+1)	10 stamen or fewer, rarely numerous, free or variously united	5 to numerous stamens, free or attached to base of corolla	1 to 6 stamens, usually 3, delicate filaments
<b>Gynoecium</b>	1 to numerous, carpals	2 united carpals, ovary	1 carpal with 1 locule, ovary superior, style	1 carpal, ovary superior,	1 carpal, ovary unilocular,	3 united carpals, stigmas

2A, 2Z, A, 2E

2nd & last are only hypo while other are Peri.



	separate or variously united, ovary superior sometimes inferior	oblique, superior, bilocular or imperfectly 4-locular by false septum	long & slightly bent	unilocular, stigma simple	superior, many ovules	usually large and feathery
Placentation	Basal in apocarpous, axile in syncarpous <i>→ ovary &gt; 1 all free</i> <i>→ ovary &gt; 2 fused</i>	Axile	Marginal	Marginal	Marginal	Axile
Fruit	Fleshy	Fleshy & dry	Legume or Pod	Legume	Legume, dehiscent or indehiscent	Grain or caryopsis

## ECONOMIC IMPORTANCE

Use as food	Apple, pear, peach, almond, apricot, strawberry	Potato, tomato, pepper, ground cherry, egg plant (brinjal)	Pulses e.g. gram, pea, bean. Pulses are rich in proteins	Bauhinia variegata (vegetable), Tamarindus indica (acidic fruit)		Cereals and millets. Wheat, oats, corn, rice, barley, rye
Ornamentals	Genus Rosa	Petunia, Nicotiana, Cestrum, Solanum	Lathyrus, Lupinus, Clitoria, Butea	Bauhinia variegata (kachnar), Cassia fistula, Parkinsonia	Mimosa pudica, Acacia melanoxylon, Prosopis	Bambusa
Use in medicine		Alkaloids e.g. Atropa belladonna, Atura (atropin & daturin)	Glycyrrhiza glabra (cough & cold), Clitoria ternatea (snake bite)	Cassia alata (ringworm, skin diseases), Cassia senna & Cassia obovata (senna = laxative), Cynometera cauliflora (skin diseases)	Tender leaves of Acacia nilotica (blood purifier)	Leaves of bamboo (cure for cough and cold of horses)
Other substances	Cretaeagus (walking sticks), Pyrus pastia (tobacco pipes), Rose petals (gulkand), Rose oil (perfumes)	Nicotiana tobacum (tobacco). Capsicum is source of vit. A & C.	Medicago sativa, Melilotus, Trifolium (fodder), Butea, Dalbergia (timber), Arachis hypogea (edible, peanut)	Bark of Bauhinia & Tamarindus (tanning), Heartwood (longwood) of Haematoxylon (dye haematoxylin)	Acacia, Albizzia, Xylia (wood), Albizzia lebbek (cabinet work, railway carriage), Acacia	Fodder, Cymbopogon squarrosus i.e. lemon grass (lemon grass oil = aromatic oil), paper, Rye.





	, Rose water (Ark-e-Gulab). Rose water is produced when rose is distilled with water		oil)Indigofera tinctoria (indigo dye), Butea monosperma (yellow dye), Seed of Abrus precatorious (weights as rattit)		nilotica & Acacia senegal (Arabic gum), Acacia catechu (dye i.e. katha)	barley, corn, rum molasses of sugar cane (whisky-beverage), Saccharum munja (fibers, rope), Bambusa (huts, boats, carts, pipes, mats, baskets, fans, hats, umbrella)
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1. The branches of \_\_\_\_\_ provide excellent walking sticks and wood.
2. Pulses are rich in \_\_\_\_\_ contents.
3. The leaves of \_\_\_\_\_ are used to cure ringworm.
4. \_\_\_\_\_ a dye is obtained from *Acacia catechu*.
5. Inflorescence of grasses is compound composed of units called \_\_\_\_\_.
6. *Oryza* is member of \_\_\_\_\_ family.

Answers: (1) Crataegus (2) Protein (3) *Cassia alata* (4) Katha (5) Spikelets (6) Grass





## VALUES

Property	Value
Species of plants	360,000
Number of species of liverworts	900
Period for evolution leaf	15-20 million years
Area occupied by annulus in <i>Adiantum</i>	3/4
Area occupied by stomium in <i>Adiantum</i>	1/4
Evolution of seed started about	390 million years ago
First complete seed appeared about	365 million years ago
Species of angiosperms	235,000





# PRACTICE EXERCISE

40 mins  
Time Yourself

1. Which of the following statement about plants is incorrect?  
 (a) All are eukaryotes. (b) They are multicellular.  
 (c) Non- motile organisms. (d) Are heterotrophes.
2. Bryophytes are called amphiabians of plant world because  
 (a) Bryophytes like amphibian ancestors are one of the most primitive organisms in this world.  
 (b) Bryophytes like amphibian live in damp shady places and close to water body.  
 (c) Amphibians have close relation with bryophytes in their habitat.  
 (d) All of these.
3. Hornworts are included in sub-class  
 (a) Anthoceropsida (b) Bryopsida  
 (c) Hepaticopsida (d) Psilopsida
4. Horsetails are included in class  
 (a) Sphenopeida (b) Lycopsida  
 (c) Psilopsida (d) Pteropsida
5. Antheridia and archegonia are born on \_\_\_\_\_ in bryophytes  
 (a) Sporophyte (b) Gametophyte  
 (c) Both of these (d) None of these
6. In bryophytes, fertilization takes place in  
 (a) Antheridia (b) Archegonia  
 (c) Water (d) Ovule
7. Which of the following statement about alternation of generation in bryophytes is incorrect?  
 (a) It involves alternation of morphologically different generations.  
 (b) Their gametophyte is independent while sporophyte depends upon gametophyte for nutrition.  
 (c) Both the gametophyte and sporophytes are haploid generations, thus can produce haploids gametes to continue the diploid number on fertilization.  
 (d) Spore formation occurs through meiosis.
8. Antherozoids, the male gamete in bryophytes, are attracted towards Archegonium i.e., female sex organ by  
 (a) Phototactic phenomenon. (b) Chemotactic phenomenon.  
 (c) Geotropic phenomenon. (d) Chemotropic movement
9. Which of the following of bryophytes are the simplest one?  
 (a) *Porella* (b) *Funaria*  
 (c) *Anthocerus*. (d) *Polytrichum*
10. The zygote formed in liverworts is  
 (a) Unicellular (b) Multicellular  
 (c) Multinucleate (d) None of these
11. Sporophyte is  
 (a) Monoploid (b) Haploid  
 (c) Diploid (d) Polyploidy



12. Mosses are included in sub-division
  - (a) Anthoceropsida
  - (c) Bryopsida
  - (b) Hepaticopsida
  - (d) Lycopside
13. Ferns are included in
  - (a) Psilopsida
  - (c) Sphenopsida
  - (b) Lycopside
  - (d) Pteropsida.
14. The simplest of all bryophytes are
  - (a) Thallophytes
  - (c) Mosses
  - (b) Embryophytes
  - (d) Liverworts
15. Antheridiophore and archegoniophore are found in
  - (a) Marchantia
  - (c) Both of these
  - (b) Funaria
  - (d) None of these.
16. Protonema is
  - (a) Thallus like
  - (c) Fungus like
  - (b) Algae like
  - (d) Plant like
17. Of the following, which one is most advanced?
  - (a) Anthoceropsida
  - (c) Hepaticopsida
  - (b) Bryopsida
  - (d) None of these
18. In Hornworts, the band of meristematic tissue is found near.
  - (a) Foot
  - (c) Spore producing region
  - (b) Gamete producing region
  - (d) At junction of a & c
19. The part of sporophyte which is called sporangium is
  - (a) Capsule
  - (c) Stalk
  - (b) Foot
  - (d) None of these.
20. The first cell of the sporophyte generation is
  - (a) Oospore
  - (c) Spore
  - (b) Spore mother cell
  - (d) Gamete
21. Stem of Psilophyton, an example of psilopsida, is differentiated into an underground rhizome, and an aerial part, both of which are \_\_\_\_\_ branched.
  - (a) Isotomous
  - (c) Trichotomously.
  - (b) Dichotomously.
  - (d) Multichotomously.
22. Which of the following group of tracheophyta has expanded or scale like leaves which are always arranged in whorls?
  - (a) Psilopsida.
  - (c) Sphenopsida.
  - (b) Lycopside.
  - (d) Pteropsida.
23. Which of the following tracheophytes are leafless?
  - (a) Psilopsida.
  - (c) Sphenopsida.
  - (b) Lycopside.
  - (d) Pteropsida.
24. Sporangia of which of the following tracheophytes develop singly on the upper side of sporophylls, which may or may not be arranged to form strobili.
  - (a) Psilopsida.
  - (c) Sphenopsida.
  - (b) Lycopside.
  - (d) Pteropsida.
25. Gametophyte of Psilopsida, develops a symbiotic association with which of the following?
  - (a) Algae.
  - (c) Protozoa.
  - (b) Bacteria.
  - (d) Fungus.



26. Which of the following is an example of the living member of Psilopsida?
  - (a) *Rhynia*
  - (b) *Psilophyton*
  - (c) *Psilotum*
  - (d) *Cooksonia*
27. In term of spore production *Selaginella* is characterized by
  - (a) Homosporous
  - (b) Heterosporous
  - (c) Both, depending upon the conditions.
  - (d) None of these.
28. Which of the following tracheophytes are also called arthropytes?
  - (a) Psilopsids
  - (b) Lycopsids
  - (c) Sphenopsids
  - (d) Pteropsids
29. *Equisetum* is an example of
  - (a) Psilopsida.
  - (b) Lycopsida.
  - (c) Sphenopsida.
  - (d) Pteropsida.
30. Today, the land habitat is dominated by
  - (a) Fungi
  - (b) Gymnosperms
  - (c) Angiosperms
  - (d) Tracheophytes.
31. Of the following, which one is not the characteristic of the plants included in psilopsida?
  - (a) Gametophyte is colourless
  - (b) They have mycorrhizal association.
  - (c) Rhizoids bear Rhizome.
  - (d) Aerial branches have veinless outgrowths
32. Megaphylls are characteristic for
  - (a) Ferns
  - (b) Seed plants
  - (c) Both of these
  - (d) None of these.
33. The dichotomously branching system has shape similar to
  - (a) U
  - (b) R
  - (c) Y
  - (d) Fork.
34. The space between the overtopped dichotomous branches was occupied by a sheet of \_\_\_\_\_ cells during evolution of megaphyllas.
  - (a) Sclerenchyma
  - (b) Chlorenchyma
  - (c) Parenchyma
  - (d) Collenchyma
35. Production of two types of spores is known as
  - (a) Heterospory
  - (b) Homospory
  - (c) Heterogamy
  - (d) Gamospory.
36. Ground pries are also known as
  - (a) Lycopods
  - (b) Spike mosses
  - (c) Both of these
  - (d) None of these.
37. Which of the following plant group first formed true leaves?
  - (a) Psilopsida.
  - (b) Lycopsida.
  - (c) Sphenopsida.
  - (d) Pteropsida
38. Megaphylls i.e, leaves with divided veins with an expanded lamina is a characteristic of:
  - (a) Lycopods.
  - (b) Ferns
  - (c) Seed plants.
  - (d) Both b and c.
39. The arrangement of unequal dichotomous branches in one plane during evolution of leaves is called
  - (a) Overtopping.
  - (b) Fusion
  - (c) Webbing.
  - (d) Planation.



40. Which of the following statement about filicinae, a group of tracheophytes, is incorrect:
- They belong to sphenopsida.
  - They are seedless and their leaves are called fronds.
  - They live in shady and moist areas.
  - They show circinate vernation.
41. Due to which property of *Adiantum*, an example of Filicinae, is called Maiden-hairfern?
- Its short thick branched horizontally growing rhizome.
  - Fibrous adventitious roots arise from the lower side of rhizome
  - Shows heteromorphic alternation of generation.
  - Stipe (stalk) and rachis of leaf have black, smooth and shiny hair-like structures
42. Specialized protective coverings around megasporangium, which vary in number are called:
- Sporangium.
  - Integuments
  - Ovule
  - Pericarp
43. In which group of tracheophytes, ovules are born on the exposed surface of megasporophylls?
- Spheospsida.
  - Filicineae.
  - Gymnosperms.
  - Angiosperms.
44. *Pinus*, *Taxus*, and *Picea* belong to
- Spheospsida.
  - Filicineae.
  - Gymnosperms.
  - Angiosperms
45. In life cycle of *Pinus*, megaspores produced by megasporangium divide into 4 megaspores by
- Mitosis.
  - Meiosis.
  - Both depending upon the condition.
  - None of these.
46. Microspore of a seed plant that contain male gametophyte including the gamete is called
- Pollen grain
  - Ovule.
  - Microgametophyte.
  - Microsporangium.
47. Gymnosperms constitute \_\_\_\_\_ of total world forests:
- 1/2
  - 1/3
  - 1/4
  - 1/5
48. Monocots are characterized by
- Number of sepals and petals are 2 or multiple of 2.
  - Number of sepals and petals are 3 or multiple of 3.
  - Number of sepals and petals are 4 or multiple of 4
  - Number of sepals and petals are 5 or multiple of 5.
49. Which of the following statement about dicots is incorrect?
- They have 4 or 5 sepals and petals or their multiple.
  - They have parallel vein pattern on their leaves.
  - They are both herbaceous and woody
  - Vascular bundles are ring shaped in their stems.
50. Maize is an example of
- Monocot.
  - Dicot.
  - Gymnosperm
  - None of these.



Chapter

# 10

# KINGDOM ANIMALIA

Development of Complexity

Grade Bilateria

Classification of Kingdom Animalia

Grade Radiata

Diploblastic & Triploblastic Organization

## II Introduction



### III Invertebrates

Phylum Porifera

Phylum Cnidaria

Phylum Platyhelminthes

Phylum Aschelminthes

Phylum Annelida

Phylum Arthropoda

Phylum Mollusca

Phylum Echinodermata

Phylum Hemichordata

### III Phylum Chordata

Classification

Superclass Pisces

Class Amphibia

Class Reptilia

Class Aves

Class Mammalia

Class Cyclostomata

Class Chondrichthyes

Class Osteichthyes

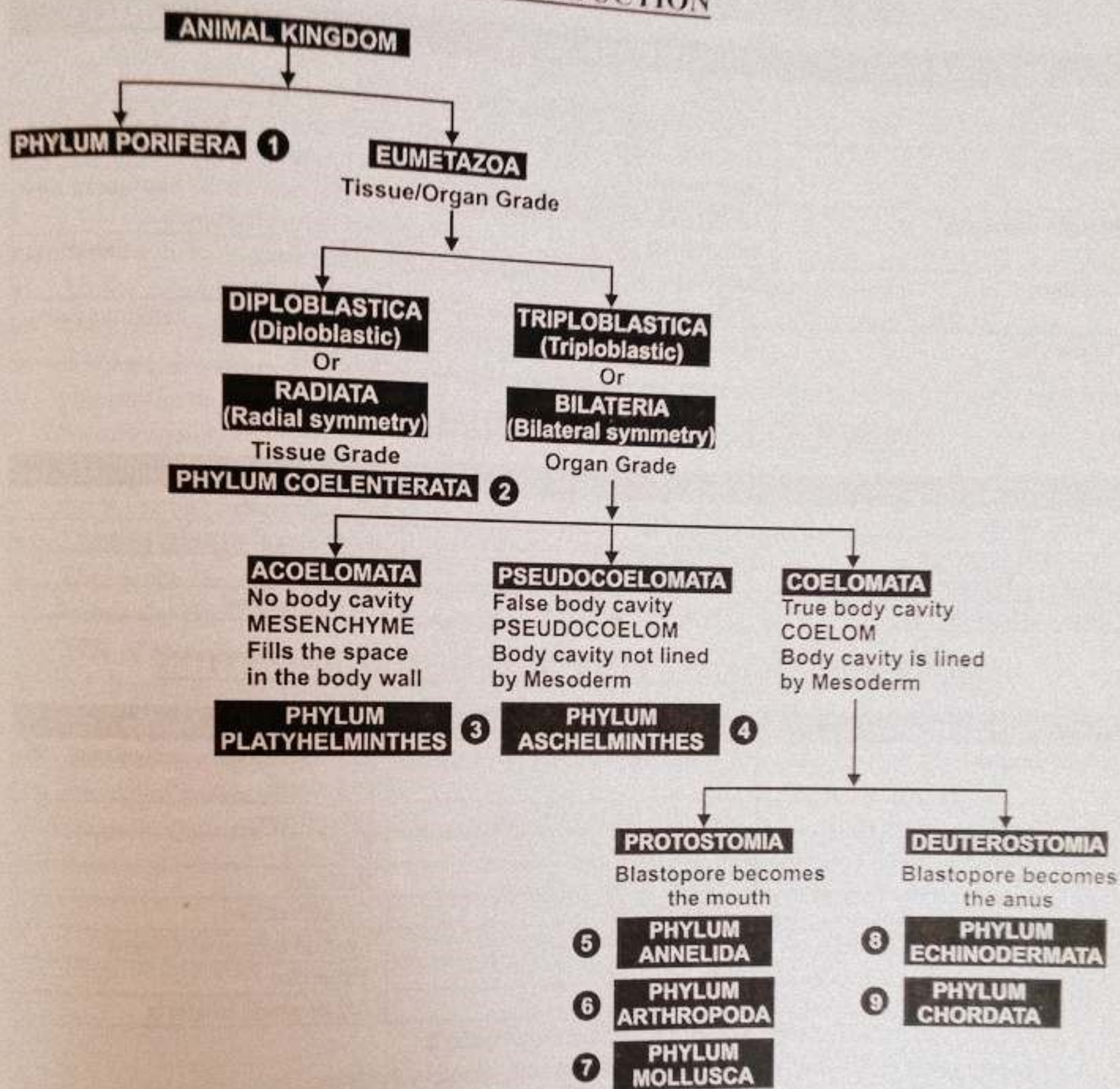
Adaptations for Parasitic Mode of Life

Classification of Annelids, Arthropods & Molluscs





## INTRODUCTION



- Word **animalia** has been derived from Latin word 'anima' meaning 'breath or soul'.
- Eumetazoa consists of nearly **29 phyla**.
- **Grade radiata** includes animals (coelenterata) with radial symmetry and diploblastic organization.
- **Grade bilateria** includes animals (phyla onward coelenterata) with bilateral symmetry and triploblastic organization.
- Symmetry in which can be divided into two equal halves in many planes is called **radial symmetry**.
- Symmetry in which animal can be divided into two equal halves in only one plane is called **bilateral symmetry**.



PROTEROSTOMES AND DEUTEROSTOMES

DIFFERENCE	PROTEROSTOMES	DEUTEROSTOMES
Cleavage	Cleavage or division of the zygote is spiral and determinate	Cleavage is radial and indeterminate
Mesoderm	Derived from cells of lip of blastopore	Derived from wall of developing gut (archenteron)
Mouth and anus	Mouth from blastopore or its anterior margin	Mouth anterior to blastopore and anus from blastopore
Coelom	Splitting of mesoderm (Schizocoelous)	Outpouching of archenteron (Enterocoelous)
Examples	Annelids, molluscs, arthropods	Echinoderms, hemichordates, chordates

SPIRAL CLEAVAGE AND RADIAL CLEAVAGE

Difference	Spiral	Radial
Other name	Determinate	Indeterminate
Planes of cleavage	Non-symmetrical to poles	Symmetrical to polar axis
Lines and cells	Diagonal	Tiers
Fate of blastomere	Pre-determined, foretold	Not determined

DIPLOBLASTIC AND TRIPLOBLASTIC ORGANIZATION

Feature	Diploblastic	Triploblastic
Body layers	2, ectoderm & endoderm	3, ectoderm, mesoderm & endoderm
Middle layer	Mesenchyma or mesoglea	Mesoderm
Symmetry	Radial	Bilateral
Grade	Radiata	Bilateria
Specialization	Lesser degree	Greater degree
Transport system	No, simple diffusion	Special transport system
Digestive system	Sac like	Tube like
Example	Phylum Cnidaria	All of grade bilateria

- **Ectoderm** gives rise to integumentary and nervous system.
- **Mesoderm** gives rise to muscular, skeletal and reproductive system.
- **Endoderm** forms the lining of digestive tract and other glands of digestive system e.g. liver.
- Digestive system having only one opening behaving both as mouth and anus is called **sac-like digestive system**.
- Digestive system having two opening i.e. mouth and anus is called **tube-like digestive system**.

TRIPLOBLASTIC ORGANIZATION

Feature	Acoelomates	Pseudocoelomates	Coelomates
Cavity	No body cavity	False body cavity	True body cavity
Middle structure	Loos mesodermal mesenchyma or parenchyma	Pseudocoelom developing from blastocoel	Coelom produced by splitting of mesoderm
Gut	Sac-type	Tube-type	Tube-type
Examples	Platyhelminthes	Aschelminthes	From annelida to chordata



- *Pseudocoelom* is different from coelom in the sense that it does not developed from mesoderm (produced from blastocoel of embryo) and not lined by coelomic epithelium.
- In *coelomates*, coelom splits into outer parietal layer, which underlies the body wall and visceral layer, which covers the alimentary canal and cavity between them is coelom.
- The word 'porifera' is derived from Latin 'pori' meaning 'pore' and 'ferra' meaning 'to bear'.

### PHYLUM PORIFERA

- Phylum porifera is also called *parazoa, sponges & pore bearing animals*.
- All are *aquatic*. Out of total *5000 species* 150 live in fresh water while all other are marine.
- They *lack symmetry & tissue organization*.
- *Body wall* is formed of an outer layer, *pinacoderm* (made of pinacocytes) & an inner layer *choanoderm* (made of collar cells or choanocytes). Between these layers, there is gelatinous *mesenchyme*.
- They range in size from few millimeters to more than one meter tall. *Scolymastra joubini* is more than a meter tall.
- There is a single cavity inside the body, the *spongocoel*.
- The pores through which water enters the body are called *ostia* and pore by which water leaves the body is known as *osculum*.
- *20% of their food* is zooplankton & phytoplankton & *80%* is detrital organic matter.
- Adult sponges are *stationary* while their larva are able to move.
- *Skeleton* contains needle-like *spicules* which are calcareous or siliceous.
- Asexual reproduction is by *budding*. The buds may be external or internal. The internal buds are called *gemmules*.
- Sexually they are *hermaphrodite* and *protandrous*. *Fertilization* occurs in mesenchyme.
- *Sycon* is typical marine sponge, *Leucosolenia* consists of erect tubes, *Euplectella* (Venous flower basket) has glassy framework & *Spongilla* is freshwater sponge.
- Their skeleton is *used for* washing and bathing. They absorb water, fluids and blood in surgical operations and also for sound absorption in buildings.

### PHYLUM CNIDARIA

- Phylum cnidaria is also called *coelenterata*.
- They have special cells called *cnidocytes* which give rise to *nematocysts*-the stinging cells.
- They have *diploblastic* organization.
- They have gastrovascular cavity or *enteron* which serves as digestive as well as body cavity.
- They have *radial symmetry*.
- They are *aquatic* living both in marine and freshwater.
- They range in size from microscopic *Hydra* to macroscopic *Brachioceranthus* (two meter in length).
- They are found in two basic form, the *polyps* and the *medusae*.
- Polyps are cylindrical, nutritive, and asexually reproducing while medusae are umbrella like, free swimming and sexually reproducing.
- Mouth is surrounded by a series of *tentacles* which bear nematocysts.
- They are *carnivores*.



- They have *diffused type of nervous system*.
- Their *exoskeleton* is formed of calcium carbonate.
- Asexually they reproduce through *budding* while sexually they are hermaphrodite.
- *Obelia* has three types of zooids, blastostyle or gastrozooids, gonozooids & medusae.
- They show *alternation of generations*, both generations being diploid.
- The occurrence of structurally and functionally more than two different types of individuals, called zooids within the same organism is called *polymorphism*.
- *Hydra* is freshwater coelenterate that exists only in polyp form.
- *Obelia* is marine colonial organism.
- In *Aurelia* (Jelly fish), polyp is reduced and medusae is dominant.
- *Actinia* (sea anemone) is polyp in which enteron is divided by mesenteries.
- *Medrepora* (corals) are important in formation of chalk and lime stone.

### PHYLUM PLATYHELMINTHES

- Animals of phylum platyhelminthes are called *flatworms*.
- Body is soft and *dorsoventrally compressed*.
- They are *triploblastic acoelomate*.
- They show *bilateral symmetry*.
- They are mostly *endoparasites* and few are free living.
- The most common examples are *Taenia solium* (tape worm), *Fasciola hepatica* (liver fluke) and *Schistosoma* (blood fluke).
- Their size ranges from few millimeter (10 mm in case of Planaria to several meters like tape worm).
- They have branching *sac type digestive system*.
- *Excretory system* consists of branching tubes ending in bulb-like cells, the flame cells.
- *Nervous system* contains nerves and ganglia.
- Free living form move by *cilia*.
- They *reproduce* asexually by fission and regeneration and sexually they are hermaphrodite.
- *Dugesia* (Planaria) is a free living example.
- *Liver fluke* is an endoparasite in sheep & humans residing in bile duct. It completes its life cycle in snail, sheep or man.
- *Tape worm* is an endoparasite of humans, cattle and pig. Intermediate host is pig or cattle. Their body is ribbon-like and is divided into segments called *proglottids*.

### ADAPTATIONS FOR PARASITIC MODE OF LIFE

STRUCTURES PRESENT	STRUCTURES ABSENT/REDUCED
Resistant cuticle	Epidermis
Adhesive organs (Suckers or hooks)	Degenerated muscular & nervous system
Complicated reproduced system	Simplified digestive system
Large number of ova	
Complexity of life cycle (in two host)	





1. Eumetazoa consists of nearly \_\_\_\_\_ phyla.
2. Symmetry in which body of an animal can be divided into two equal halves in single plane is called \_\_\_\_\_.
3. In deuterostomes, coelom is formed as outpouching of \_\_\_\_\_.
4. Members of phylum \_\_\_\_\_ lack symmetry and tissue organization.
5. Detrital organic matter constitutes \_\_\_\_\_% of food of poriferans.
6. Cnidarians have \_\_\_\_\_ symmetry.
7. Cnidarians have \_\_\_\_\_ type of nervous system.
8. Obelia has \_\_\_\_\_ types of zooids.
9. Free living flatworms move by \_\_\_\_\_.
10. Body of tape worm is ribbon like and is divided into segments called \_\_\_\_\_.

### PHYLUM NEMATODA

- Animals presents in phylum nematoda are called *roundworms* or *aschelminthes*.
- They have pointed ends.
- They are *triploblastic* and *pseudocoelomates*.
- Body is *unsegmented* and shows *bilateral symmetry*.
- **Digestive system** is tube-like.
- They have "*tube within tube*".
- **Excretory system** consists of two longitudinally running excretory canals that open through an excretory pore at anterior end on ventral side of body.
- **Nervous system** has pharyngeal nerve ring with four nerve cords (dorsal, ventral and lateral).
- Sense organs are in form of *sensory papillae* present on the lips at the anterior end.
- They have only *longitudinal muscles* arranged in four bands, two dorso-lateral and two ventro-lateral.
- **Sexes** are separate.
- *Ascaris lumbricoides*, is an intestinal parasite of man.
- *Rhabditis* is free living genus.
- *Enterobius vermicularis* (pin worm) is a parasite of human caecum, colon and appendix. Its movement causes intense itching of anus, inflammation of mucous membrane of colon and appendix resulting in insomnia and loss of appetite.
- *Ancylostoma duodenale* (Hook worm) is a parasite of human small intestine. It releases an anticoagulant and causes severe anemia & retards physical and mental growth.

Answers: (1) 29 (2) Bilateral Symmetry (3) Archenteron (4) Porifera (5) 80% (6) Radial (7) Diffused (8) 3 (9) Cilia (10) Proglottids



PHYLUM ANNELIDA

- Animals present in phylum annelida are called *segmented worm* or annelids (from Latin word meaning 'little ring').
- Body is *metamerically segmented*.
- They are *triploblastic* and *acoelomate*.
- Mouth is overhung by a lobed structure called *prostomium*.
- There are *two groups of muscles* i.e. circular (along radius of body) and longitudinal (along length of body).
- Excretion takes place by specialized structures called *nephridia*.
- *Nervous system* contains simple brain and a solid double, longitudinal, ventral nerve cord. Nerves arise in each segment from the nerve cord.
- They have *closed type of circulatory system*.
- They contain both *longitudinal and circular muscles*. Locomotion is brought about by muscles and *hydrostatic skeleton*. The organs of locomotion are *chitinous chaetae* or seta. Chaetae are absent in leech.
- They show sexual reproduction and sexes are separate. They develop *trochophore larva* during development.
- Common examples are *neries, earthworm, leech* etc.

CLASSIFICATION OF ANNELIDA

CHARACTER	POLYCHAETA	OLIGOCHAETA	HIRUDINEA
Structure	They have a distinct head region with eyes and structures called palps & tentacles.	These animals have external & internal segments. Head region not prominent or distinct	They have body with fixed number of segments. Each segment has additional circular rings or markings called annuli. No distinct head
Locomotion	Organs of locomotion are parapodia.	Organs of locomotion are setae	No organs of locomotion.
Sexes	Usually separate	Hermaphrodite	Mostly hermaphrodite
Trachophore larvae	Present	Not present	Present
Habitat	Mostly aquatic (marine)	May be terrestrial or aquatic	Aquatic
Examples	Neries Chaetopterus	Lumbricus terrestris. Pheretima posthuma	Hirudo medicinalis

PHYLUM ARTHROPODA

- Animals of **PHYLUM ARTHROPODA** are called joint-footed animals (arthros=jointed + pods=feet).
- *Insects* are most common arthropods on the earth.
- Their body is *segmented*.
- They have *jointed appendages*.
- They are found in all types of *habitats*.
- They have *haemocoel*.
- *Digestive system* is tube like.



- **Excretory system** consists malphigian tubules. The nitrogenous wastes are excreted in form of solid uric acid.
- **Nervous system** consists of paired ganglia and ventral double nerve cord. The sensory organs are usually a pair of compound eyes and antennae.
- **Respiration** occurs through tracheal system having openings called spiracles. Aquatic arthropods respire through gills and book lungs.
- Their **blood circulatory system** is open type. Blood is colourless without haemoglobin.
- They have **chitinous exoskeleton**.
- They can swim, crawl or fly. The organs of **locomotion** are paired appendages.
- Life history of insects is characterized by **metamorphosis**.
- In **complete metamorphosis**, egg develops into larva which is converted into motionless pupa that finally develops into adult.
- In some primitive insects, the metamorphosis is **incomplete**. The larva resembles adult and is called nymph or instar.

### CLASSIFICATION OF ARTHROPODS

CHARACTER	CRUSTACEA	INSECTA	ARACHNIDA	MYRIAPODA
Habitat	Aquatic	Found everywhere	-	-
Sexes	Mostly separate	Separate & oviparous	Separate & oviparous	-
Development	-	Through metamorphosis	No true metamorphosis.	-
Head parts	2 pair of antennal appendages, 1 pair of mandibles & 2 pairs of maxillae.	A pair of antennae & compound eyes on head	No appendages of antennae & no jaws. A pair of chelicerae with claws & two pairs as pedipalps.	A pair of antennae and a pair of eyes
Body segments	On the dorsal side of the cephalothorax, the exoskeleton is in the form of carapace. In exoskeleton, deposition of salts in addition to chitin makes it move firm.	Three distinct regions; Head:- Usually vertical to the body and jaws are ventral. Thorax:- Three segments. Abdomen:- Varying number of segments.	Anterior segments fused to form a cephalothorax. Abdomen may be segmented or unsegmented with or without appendages.	A large number of segments each having a pair of legs.
Respiration	Through gills	-	By gills, lungs or book lungs	-
Example	Daphnia, cyclops, crabs, lobsters, prawn, woodlouse etc.	Dragonfly mosquito, butterflies, moths, wasps, beetles etc.	Scorpions, spiders, mites and ticks.	Centipedes and millipedes

- **Chitin** is non-living, non-cellular and secreted by underlying epidermis.
- Chitin is protein-carbohydrate compound.
- Process of shedding of exoskeleton is called **moulting or ecdysis**.



## ECONOMIC IMPORTANCE

Harmful Insects	Beneficial Insects
Transmit diseases (act as vectors)	Honey, silk & wax
Spoilage of food	Predaceous to other insects
Spoilage of crops	Larvae source of food for fish

## PHYLUM MOLLUSCA

- There are approximately 50,000 species of phylum mollusca and it is second largest phylum of invertebrates.
- They are *triploblastic acoelomates* exhibiting *bilateral symmetry*.
- The body is covered by a glandular epithelial envelop called *mantle*, which secretes calcareous shell.
- They are found both in aquatic and terrestrial *habitats*.
- The body is *unsegmented and soft*.
- The body can be divided into *head, a ventral muscular foot and a dorsal visceral mass*. In the mouth cavity of many mollusks there is a rasping tongue-like *radula* provided with many horny teeth.
- Digestive system* consists of gut with two openings, the mouth and the anus.
- The excretory organs are paired *nephridia*.
- Circulatory system* is open type except for cephalopods.
- The gaseous exchange is commonly by *gills*.
- The *nervous system* consists of three pairs of interconnected ganglia present in the head, foot and body regions.
- The organ of locomotion is a *muscular foot*.
- The *sexes* are separate. Trochophore larva develops during embryological development.

## CLASSIFICATION OF MOLLUSCA

CHARACTER	CRUSTACEA	BIVALVIA	CEPHALOPODA
Symmetry	Asymmetrical	Bilateral	Bilateral
Shell	Usually coiled one piece of shell	Two pieces of shell	Much reduced
Habitat	Aquatic, and terrestrial	Aquatic	Aquatic
Respiration	Aquatic species have lungs. In land, the mantle cavity is converted into lungs	By plate-like gills	-
Examples	Helix aspersa (land slug)	Mytilus, Anodonta, Ostrea	Loligo, Sepia, Octopus

## PHYLUM ECHINODERMATA

- Members of phylum echinodermata are also called '*spiny-skinned animal*'.
- There are over 1000 known species of echinoderms.
- They have *mesodermal endoskeleton* in form of spines.
- They are *triploblastic acoelomates* and exhibit *radial symmetry*.
- They are *exclusively marine*.
- Their larval forms exhibit bilateral symmetry while adult forms radial symmetry.
- They have *water vascular system*. Water enters the canals through a sieve-like plate called madreporite present on aboral surface.
- The motile species move with help of *tube feet*.



- They have no brain instead *pharyngeal nerve ring* is present.
- *Circulatory system* is poorly organized.
- The *sexes* are separate and the fertilization is external.
- The larvae such as *bipinnaria* and *brachiolaria* are complex, exhibit bilateral symmetry and resemble those of chordates.
- *Regeneration* is common in them.

### RESEMBLANCE OF ECHINODERMS & CHORDATES

- *Radial cleavage* during development of embryo.
- *Blastopore* form the anus.
- *Phosphocreatin* is present.

### HEMICHORDATA

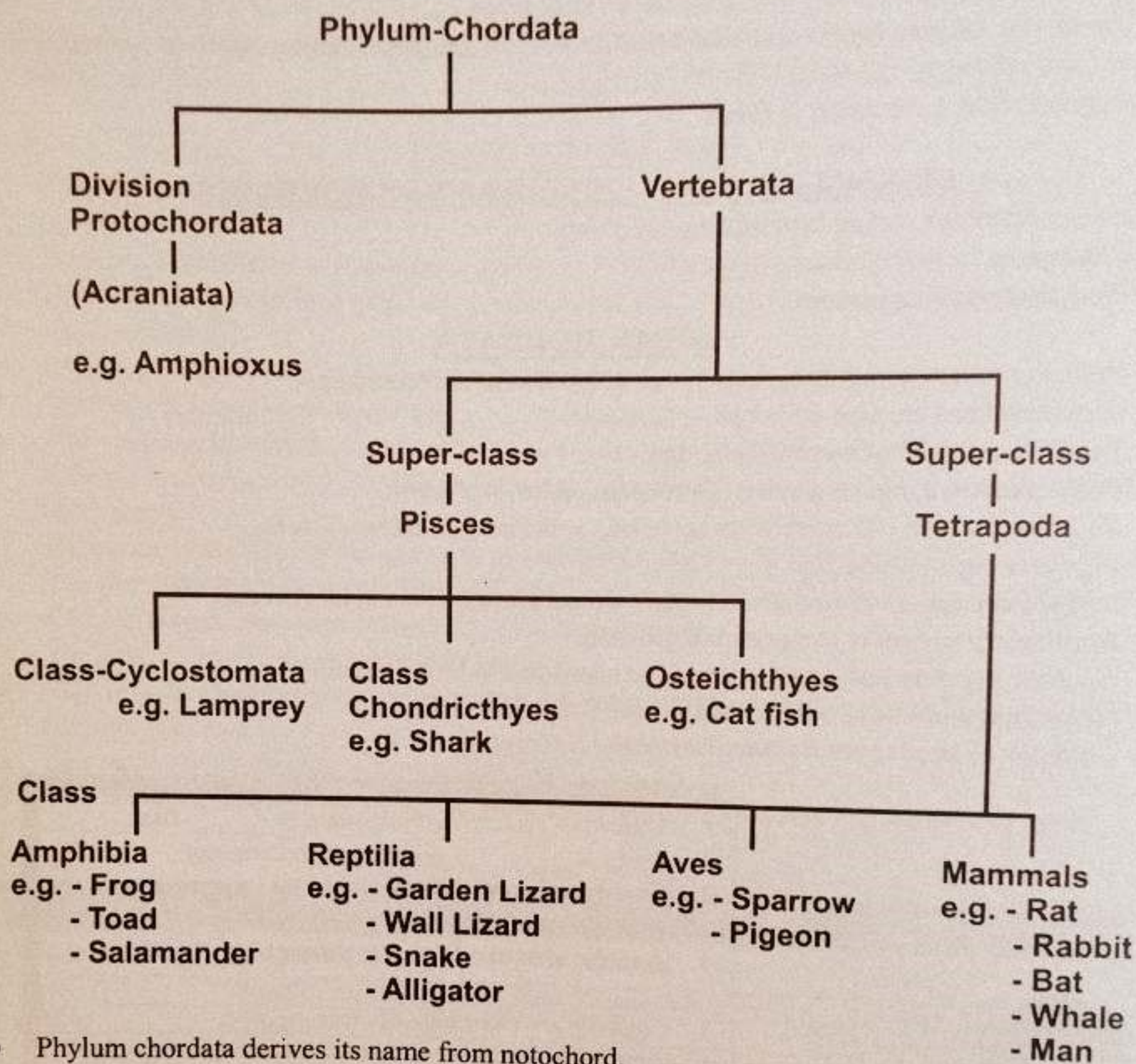
- Hemichordata is group present between echinoderms and chordates.
- Hemichordates are also called *pre-chordates*.
- They are *soft bodied* worm-like animals.
- Body is divided into an *anterior proboscis, collar and trunk*.
- *Body wall* is made of unicellular epidermis with mucous-secreting cells.
- *Digestive tract* is tube-like.
- *Circulatory system* consists of a median dorsal and a median ventral vessel.
- *Respiratory system* is composed of gill-slits.
- *Excretory system* has single glomerulus connected to blood vessels.
- *Nervous system* has a sub-dermal plexus of cells and fibers.
- Common examples are *Balanoglossus* and *Saccoglossus*.



1. Digestive system in nematodes is \_\_\_\_\_ like.
2. Body is \_\_\_\_\_ segmented in annelids.
3. Excretion in annelids takes place by specialized structures called \_\_\_\_\_.
4. Aquatic arthropods respire through \_\_\_\_\_ & \_\_\_\_\_.
5. Cyclops are examples of class \_\_\_\_\_.
6. Process of shedding of exoskeleton in arthropods is called \_\_\_\_\_.
7. The organ of locomotion in molluscs is \_\_\_\_\_.
8. Water vascular system is characteristic of phylum \_\_\_\_\_.
9. Larva forms of echinoderms show \_\_\_\_\_ symmetry.
10. *Balanoglossus* is an example of phylum \_\_\_\_\_.

Answers: (1) Tube (2) Metamerically (3) Nephridia (4) Gills & Book Lungs (5) Crustacea (6) Metanephridia (7) Muscular foot (8) Echinodermata (9) Bilateral (10) Hemichordata



PHYLUM CHORDATA

- Phylum chordata derives its name from notochord.
- Three **fundamental** (basic) **features** of chordates are notochord, central nervous system and paired gills.
- **Notochord** is a rod-like semi-rigid body of vacuolated cells, which are filled with proteinaceous material.
- **Central nervous system** is hollow and dorsal.
- All chordates possess **paired gill openings** in embryonic stage.

SUBPHYLUM VERTEBRATA

- Vertebrates have cranium enclosing brain and vertebral column enclosing spinal cord.
- Vertebrates are placed in **two super classes** Pisces (fishes, which are strictly aquatic) and Tetrapods (four footed, which are mostly land dwelling).
- Vertebrates may be divided into **amniotes** (having foetal membranes e.g. reptilia, aves, mammals) and **anamniotes** (without foetal membranes e.g. amphibia and pisces).



SUPERCLASS PISCES

- They have **stream-lined body** (boat shaped).
- They have **swim bladder** which is a hydrostatic organ and can change the effect of gravity.
- They have paired (pectoral & pelvic) & unpaired (dorsal, caudal & anal) **fins**.
- **Heart** is with two chambers with afferent & efferent branchial system.
- Respiratory structures are **gills**.
- Super class pisces includes three important classes i.e. cyclostomata, chonrichthyes and osteichthyes.

Feature	Cyclostomata	Chondrichthyes	Osteichthyes
Common name	Most primitive, jawless	Cartilaginous	Bony
Body	Long, eel-like	Fusiform	Small fishes
Scales (exoskeleton)	No	Placoid	Dermal scales, ganoid, cycloid or ctenoid
Appendage (fins)	No paired appendages	Both paired and unpaired fins present, anterior pair of fins (pectoral fins) are enlarged	Both types, single median and paired
Mouth	Ventral suctorial	Ventral, olfactory sacs not connected	Terminal, jaws with or without teeth
Endoskeleton	Cartilaginous	Cartilaginous	Bony
Digestive system	No stomach	J-shaped stomach	Normal stomach
Circulatory system	Heart with one auricle	Many pairs of aortic arches	2-chambered heart, one atrium, one ventricle, nucleated RBCs
Respiratory system	6-14 pairs of gills	5-7 pairs of gills, no operculum	Gills supported by gill arches and operculum
Swim bladder	No	No	Present
Sexes	Separate in lamprey, hermaphrodite in hagfishes	Separate	Separate, paired gonads
Fertilization and development	External, long larval period in lamprey	Internal, oviparous or viviparous	External
Examples	Lampreys, Hagfishes	Shark (dog fish), Skates and Rays	Perch, Trout, Rohu, Palaice

- Skates and rays are **bottom dwelling fishes**.
- In **sting rays**, tail is long and whip-like and has sharp spines, which can inflict very dangerous wounds.
- **Electric rays** have dorsal muscles modified into powerful electric organs, which can give severe shocks and stun their prey.



COMPARISON OF LAND AND WATER

Feature	Land	Water
Oxygen	More	Less
Dissolved substances	Less	Many
Cover and shelter	More	Less
Support	Less	More
Breeding places	More	Less

CLASS AMPHIBIA

- Amphibians are on the border line between aquatic and true terrestrial animals.
- They are the first vertebrates to come on land.
- *Lobe-finned fish* (dipnoi) are considered as ancestors of amphibians.
- Structurally they are *between fish and reptiles*.
- *Skeleton* is mostly bony.
- *Limbs* usually four but some are legless (e.g. caecilians). Webbed feet often present.
- *Skin* smooth and moist with many glands. In some glands, pigment cells (chromatophores) present in the skin. Scales absent.
- *Heart* is 3-chambered with double circuit circulation.
- *Sexes* are separate, fertilization is external. Larva stage present.
- *Heart* is 3-chambered and respire by gills.
- *Metamorphosis* and *hibernation* are important characters.
- They are *cold blooded animals*.
- *Common examples* are frogs, toads and salamanders.

CLASS REPTILIA

- Reptiles are *truly terrestrial*.
- Reptiles flourished throughout *Mesozoic period* (225-65 million years ago).
- Reptiles of today have been derived from dinosaurs of Jurassic (195-136 million years) and Cretaceous period (136-65 million years).
- They have developed *copulatory organ* necessary for internal fertilization.
- Shell of *egg* is leathery which can resist dryness and injury. They have large yolky eggs.
- They have dry scaly *skin*.
- They have *protective membranes* i.e. amnion, allantois and chorion.
- Their *heart* is 4-chambered with ventricles incompletely partitioned except in crocodile.
- They have better developed *limbs* for efficient locomotion.
- They are *cold blooded* and *hibernate* in winter.

CLASS AVES

- BIRDS are considered to be evolved from crocodile.
- Birds share with mammals the *highest development* in the animal kingdom.
- The earliest known bird fossil is of *archaeopteryx*, two species of it have been found in Jurassic period.





- Their body is *streamlined* and spindle shaped with four divisions i.e. head, neck, trunk and tail.
- They are *warm blooded*.
- *Limbs* are adapted for flying. The forelimbs are modified into wings and hindlimbs for perching and in some for running e.g. in ostrich.
- They have *epidermal exoskeleton* of feathers, legs bear scales.
- The skeleton is light due to *air spaces*.
- The *skull* has large sockets, jaws extend into horny beak, teeth are absent.
- The *circulatory system* has 4-chambered heart with right aortic arch.
- The organ of voice is *syrinx*, located at lower end of trachea.
- *Excretory system* does not have a bladder, urine is semisolid.
- *Sexes* are separate. Fertilization is internal and eggs are of large size with much yolk.
- Only one *ovary and oviduct* is functional except eagle.
- Teeth have been replaced by *gizzard*.
- Some have *secondarily lost the power of flight* and are called running birds e.g. Ostrich, Kiwi etc.

### CLASS MAMMALIA

- The term **MAMMAL** was given by Linnaeus to that group of animals, which are nourished by milk from the breast of mother.
- Mammalia is considered highest in animal kingdom.
- It is believed that mammals have been evolved from reptilian ancestor, the *Cotylosaurs*.
- *Varanope* is an example of mammal-like reptile.
- During Jurassic period, nearly five groups of mammal-like reptiles developed mammalian characters and were 50% mammals.
- Mammals became dominant in Cenozoic period.
- Presence of hair and feeding by mammary glands are two fundamental features of mammals.
- **PROTOTHERIANS** are also called *egg-laying mammals*.
- Egg production and common cloaca are their *reptilian features*.
- Presence of hair and feeding of young ones with milk are *their mammalian features*.
- **METATHERIANS** are also called *pouched mammals* or marsupials.
- They have an abdominal pouch called marsupium where they rear young ones with milk.
- Opossum, Kangaroo and Tasmanian wolf of Australia and America are common examples.
- **EUTHERIANS** are also called *placental* or typical mammals.
- During development, *placenta* is formed between foetus and mother through which exchange of material occurs.





1. \_\_\_\_\_ is a rod-like semi-rigid body of vacuolated cells, which are filled with proteinaceous material.
2. Vertebrates having fetal membranes are called \_\_\_\_\_.
3. Fishes have \_\_\_\_\_ which is a hydrostatic organ and can change the effect of gravity.
4. Swim bladder is present in \_\_\_\_\_ fishes.
5. Skeleton is mostly \_\_\_\_\_ in amphibians.
6. Reptiles flourished through \_\_\_\_\_ period.
7. The skeleton of birds is light due to \_\_\_\_\_ spaces.
8. \_\_\_\_\_ are considered highest in animal kingdom.

VALUES

Property	Value
Phyla of eumetazoa	29
Total species of porifera	5000
Species of porifera living in fresh water	150
Zooplankton & phytoplankton as food of poriferans	20%
Detrital organic matter as food of poriferans	80%
Worms on a single rotten apple	9000
Species of mollusca	50,000
Species of echinoderms	5,000
Number of gills in cartilaginous fishes	5-7 pairs
Length of sharks	30-50 feet
Number of cranial nerves in bony fishes	10 pairs
Mesozoic period in which reptiles flourished	225-65 million years
Jurassic period for Dinosaurs	195-136 million years
Cretaceous period	135-65 million years

(1) Notochords (2) Amniotes (3) Swim bladder (4) Bony (5) Bony (6) Mesozoic (7) Air (8) Mammals

Answers:





# PRACTICE EXERCISE



- (1) Aschelminthes is also known as
  - (a) Protozoans
  - (b) Eumatazoa
  - (c) Nematodes
  - (d) Protoctist ancestors
- (2) Of the following, which one is not included in Proterostomes?
  - (a) Arthropods
  - (b) Hemichordates
  - (c) Annelids
  - (d) Molluscs
- (3) All of the following are coelomates except
  - (A) Deuterostomes
  - (b) Proterostomes
  - (c) Hemichordates
  - (d) Aschelminthes.
- (4) The name animal is derived from the word.
  - (a) Anima
  - (b) Anemia
  - (c) Aname
  - (d) All of these.
- (5) Of the following, which one is not the characteristic of Kingdom Animalia.
  - (a) All animals are ingestive heterotrophs
  - (b) All animals are eukaryotes.
  - (c) All animals develop from the dissimilar gametes i.e. large sperm and small egg.
  - (d) It is largest kingdom.
- (6) The radial symmetry is found in the animals of
  - (a) Protozoa
  - (b) Porifera
  - (c) Cnidaria
  - (d) All of these.
- (7) All the animals of the grade radiata are
  - (a) Diploblastic
  - (b) Triploblastic
  - (c) Both
  - (d) Unicellular.
- (8) Both radial and bilateral symmetry is found in the phylum
  - (a) Protozoa
  - (b) Porifera
  - (c) Echinodermata
  - (d) None of these.
- (9) Coelom that develops from the archenteron as outpouching is
  - (a) Pseudocoelom
  - (b) Enterocoelom
  - (c) Schizocoelom
  - (d) None of these.
- (10) The animals in which coelom is formed due to splitting of mesoderm are known as
  - (a) Pseudocoelous
  - (b) Schizocoelous
  - (c) Enterocoelous
  - (d) Emphicoelous
- (11) Of the following, which one is not found in series proterostomia.
  - (a) Annelida
  - (b) Arthropoda
  - (c) Mollusca
  - (d) Echinodermata.
- (12) In some cases the blastomere can produce complete embryo, the cleavage will be
  - (a) Spiral and determinate
  - (b) Radial and indeterminate
  - (c) Spiral and indeterminate
  - (d) Radial and determinate.
- (13) The fate of each blastomere is foretold. The cleavage will be as
  - (a) Spiral and indeterminate
  - (b) Radial and indeterminate
  - (c) Radial and indeterminate
  - (d) Spiral and determinate.



- (14) Of the following, which one is non-cellular in most cases in animals?  
 (a) Mesenchyme (b) Sclerenchyma  
 (c) Chlorenchyma (d) Mesoderm
- (15) In most triploblasts, after embryonic development, the three layers are represented as  
 (a) Separate layers of cells (b) Structures formed from them.  
 (c) Structures associated with them (d) Their functions in body.
- (16) Of the following, which one is not the characteristic of triploblasts.  
 (a) All of them have blood vascular system.  
 (b) They may be coelomate, pseudocoelomate or acoelomate  
 (c) They are included in grade bilateria  
 (d) All of them have digestive system.
- (17) The system well – developed in the acoelomate is  
 (a) Excretory system (b) Nervous system  
 (c) Both of these (d) Transport system.
- (18) Pseudocoelom develops from  
 (a) Blastopore (b) Plastoquinone  
 (c) Blastocoel (d) Splitting of mesoderm.
- (19) The function of coelom is  
 (a) To increase the size of the animals.  
 (b) To help in the functioning of reproductive system.  
 (c) To provide space for the development of organs and systems  
 (d) None of these.
- (20) Coelom is lined by  
 (a) Parietal mesoderm (b) Visceral mesoderm  
 (c) Mesoderm (d) Both A & B
- (21) In acoelomates gut is..... in origin.  
 (a) Ectodermal (b) Endodermal  
 (c) Mesodermal (d) None of these.
- (22) Sperms are ..... in origin.  
 (a) Ectodermal (b) Mesodermal  
 (c) Endodermal (d) None of these.
- (23) A sponge of Antarctica which is more than a meter tall is  
 (a) *Scolymastra joubini* (b) *Euplectella*  
 (c) *Spongilla* (d) *Leucoselenia*
- (24) Venus flower basket is also known as  
 (a) *Sycon* (b) *Euplectella*  
 (c) *Leucoselenia* (d) *Spongilla*.
- (25) Inner layers of the sponges are made up of  
 (a) Pinacocytes (b) Choanoderm  
 (c) Choanocytes (d) Pinacoderm.
- (26) Porifera range in size from  
 (a) Few millimeter wide to more than one meter tall.  
 (b) Few centimeter wide to more than one meter tall.  
 (c) Few decimeter wide to more than one meter tall.  
 (d) One meter wide to more than millimeter tall.
- (27) The internal buds are known as  
 (a) Spicules (b) Choanocytes  
 (c) Gemmules (d) None of these.



- (28) The sponges in which sperms develop first are included in the category of  
 (a) Peritandrous (b) Pertandrous  
 (c) Protendrous (d) Protandrous
- (29) 80% of the food of sponges consists of  
 (a) Detrital organic particles (b) Zooplankton and small animals  
 (c) Phytoplanktons (d) All of these.
- (30) The skeleton of the sponges is in the form of variously shaped needle like structures called  
 (a) Stipules (b) Spicules  
 (c) Brails (d) Spines.
- (31) The skeleton of sponges is made up of  
 (a) Calcium (b) Silica  
 (c) Both of these (d) None of these
- (32) Sperms released in water are carried to the mesenchyme in sponges by  
 (a) Amoeboid cell (b) Stipules  
 (c) Spicules (d) Spines.
- (33) Gut in pseudocoelomates is made from  
 (a) Ectoderm (b) Mesoderm  
 (c) Endoderm (d) All of these.
- (34) In sponges, fertilization takes place in  
 (a) Ectoderm (b) Mesenchyme  
 (c) Endoderm (d) Uterus.
- 35) The single main opening of the sponge cavity is  
 (a) Osculum (b) Ostia  
 (c) Spongocoel (d) None of these.
- 36) Enteron in coelenterates acts as  
 (a) Digestive cavity (b) Body cavity  
 (c) Transporting cavity (d) All of these
- 37) Which of the following are motile zooids in cnidarians?  
 (a) Polyps (b) Medusae  
 (c) Both of these (d) None of these
- 38) Exoskeleton of coelenterates is made up of  
 (a) Calcium (b) Silica  
 (c) Chitin (d) Both 'a' & 'b'
- 39) All of the following coelenterates show alternation of generation except  
 (a) Hydra (b) Obelia  
 (c) Aurelia (d) None of these
- 40) All of the following are true for platyhelminthes except  
 (a) Flatworms (b) Triploblastic  
 (c) Coelomate (d) Bilateral symmetry
- 41) Excretory system of platyhlminthes consists of  
 (a) Nephridia (b) Flame cells  
 (c) Malpighian tubules (d) Nephrons
- 42) Free living example of platyhelminthes is  
 (a) *Dugesia* (b) *Fasciola*  
 (c) *Taenia* (d) None of these





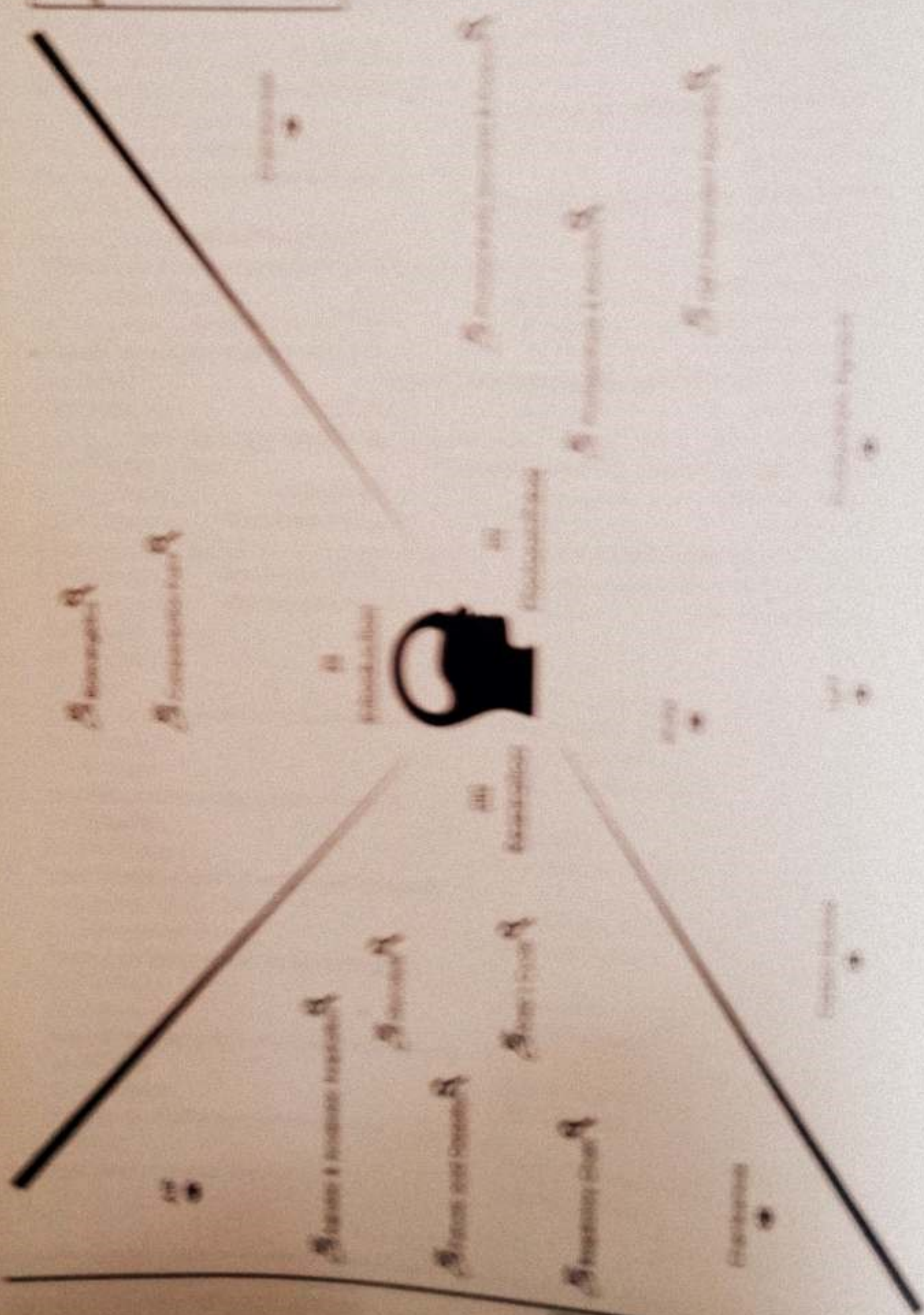
- 43) **Pseudocoelom** is character of  
 (a) Coelenterates  
 (b) Platyhelminthes  
 (c) Aschelminthes  
 (d) Annelids
- 44) **Nervous system of nematods** consists of  
 (a) Ventral nerve cord  
 (b) Dorsal nerve cord  
 (c) Lateral nerve cord  
 (d) All of these
- 45) **Which system is present in nematods?**  
 (a) Sac – like digestive system  
 (b) Tube – like digestive system  
 (c) Circulatory system  
 (d) Respiratory system
- 46) **Pin worm is common name used for**  
 (a) *Rhabditis*  
 (b) *Enterobius vermicularis*  
 (c) *Ancylostoma duodenale*  
 (d) *Taenia solium*
- 47) **Which of following system is segmentally arranged in annelids?**  
 (a) Excretory system  
 (b) Digestive system  
 (c) Circulatory system  
 (d) Nervous system
- 48) **Marine example of annelid is**  
 (a) *Neries*  
 (b) *Stylaria*  
 (c) Earthworm  
 (d) Leech
- 49) \_\_\_\_\_ are the first group of invertebrates which have developed a closed circulatory system.  
 (a) Nematods  
 (b) Annelids  
 (c) Arthropods  
 (d) Molluses
- 50) **The organs of locomotion in annelids are**  
 (a) Muscles  
 (b) Hydrostatic skeleton  
 (c) Parapodia  
 (d) Setae
- 51) **Polychaeta have**  
 (a) Tentacles  
 (b) Palps  
 (c) Eyes  
 (d) All of these
- 52) \_\_\_\_\_ are believed to have common origin with annelids.  
 (a) Nematods  
 (b) Arthropods  
 (c) Molluses  
 (d) None of these
- 53) **Aquatic arthropods respire through**  
 (a) Spiracles  
 (b) Gills  
 (c) Book lungs  
 (d) Both 'b' & 'c'
- 54) **Main blood vessel of arthropods usually**  
 (a) Lies on dorsal side  
 (b) Lies on ventral side  
 (c) Lies on lateral side  
 (d) Is not present
- 55) **True metamorphosis is not present in**  
 (a) Crustacea  
 (b) Insecta  
 (c) Arachnida  
 (d) Myriapoda
- 56) **Second largest phylum of invertebrates is**  
 (a) Porifera  
 (b) Arthropoda  
 (c) Mollusca  
 (d) Chordata
- 57) **Mantle in molluscs is present over**  
 (a) Head  
 (b) Ventral muscular foot  
 (c) Dorsal visceral region  
 (d) All of these





- 58) Circulatory system is open type in all of the following except  
(a) Arthropoda (b) Gastropoda  
(c) Pelecypoda (d) Cephalopoda
- 59) Body is globular in  
(a) Cake urchin (b) Sea Urchin  
(c) Sea cucumber (d) Brittle star
- 60) Prechordates is another name used for  
(a) Echinoderms (b) Hemichordates  
(c) Vertebrates (d) Chordates
- 61) Notochord is present throughout life in  
(a) Urochordates (b) Cephalochordates  
(c) Chordates (d) Vertebrates
- 62) Body is eel like in  
(a) Cyclostomata (b) Chondrichthyes  
(c) Osteichthyes (d) None of these
- 63) Which of the following fishes contained lungs?  
(a) Lamprey (b) Perch  
(c) Plaice (d) Dipnoi
- 64) Shell of egg is leathery in appearance in  
(a) Amphibians (b) Reptiles  
(c) Birds (d) Prototherians
- 65) Mammals became dominant in  
(a) Proterozoic era (b) Mesozoic era  
(c) Paleozoic era (d) Cenozoic era

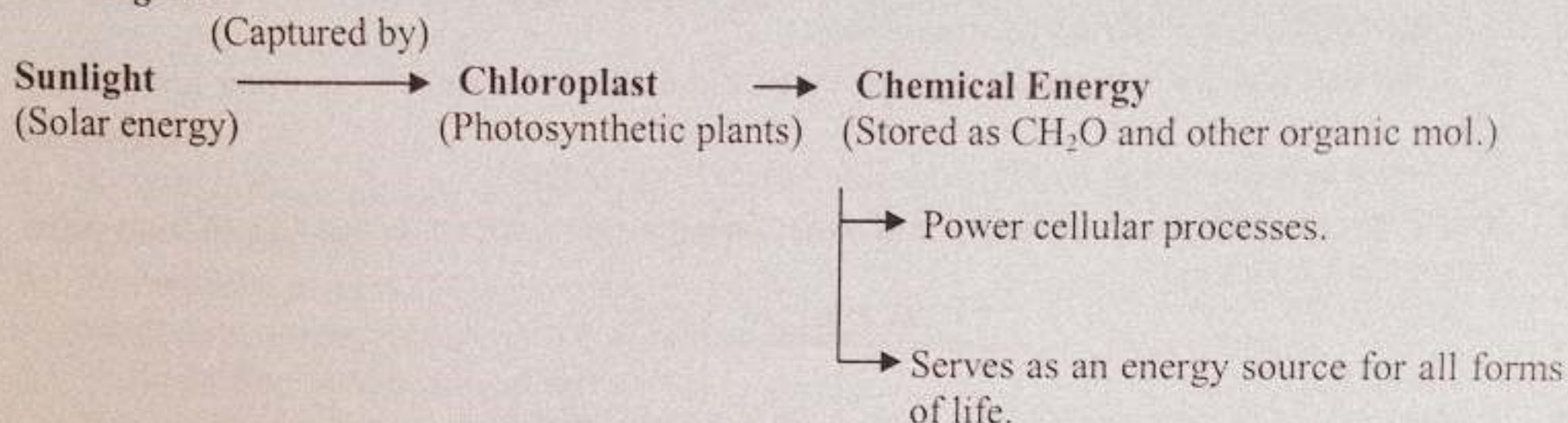






INTRODUCTION

Quantitative study of energy relationships (transformations) in biological systems is called *bioenergetics*.



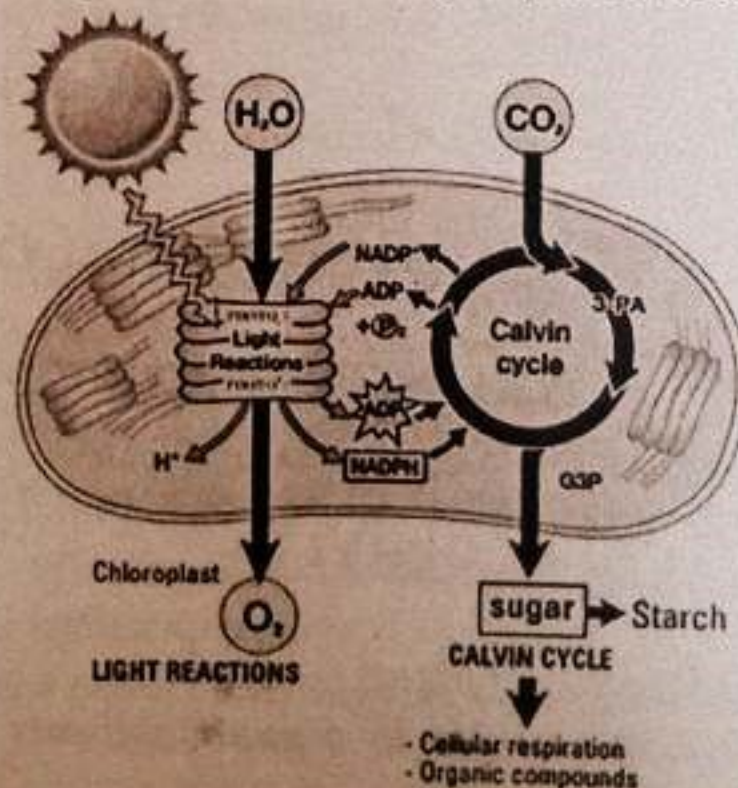
- Presence of free  $\text{O}_2$  made possible the evolution of respiration.
- *ATP* is a kind of *chemical linkage* between catabolism and anabolism.
- *Photosynthesis* acts as an *energy capturing* while *respiration* is an *energy releasing* process.

PHOTOSYNTHESIS

- *Photosynthesis* is a process in which energy poor, inorganic, oxidized compounds of carbon ( $\text{CO}_2$ ) and hydrogen ( $\text{H}_2\text{O}$ ) are reduced to energy-rich carbohydrate (glucose) using light energy that is absorbed and converted into chemical energy by chlorophyll and some other photosynthetic pigments.

Photosynthetic Reactants And Products

- $\text{CO}_2$ ,  $\text{H}_2\text{O}$  and light are the reactants while glucose and  $\text{O}_2$  are the products.
- Photosynthesis uses the products of respiration and respiration uses the products of photosynthesis.
- Photosynthesis occurs only during the day time while respiration goes on day and night.
- *Water* appears on both sides of photosynthetic reaction because it is used as a reactant in some reactions and as a product in other.
- *In darkness*, leaves respire and utilize  $\text{O}_2$  and release  $\text{CO}_2$ .
- *At Dawn & Dusk*, photosynthesis and respiration occur at same rate. So there is not net exchange of gases between atmosphere and plants. This point is called *compensation point*.
- *In day time*, rate of photosynthesis increases, so plants release  $\text{O}_2$  and use  $\text{CO}_2$ .





WATER AND PHOTOSYNTHESIS

- **Van Neil** in 1930 worked on *photosynthetic bacteria* and hypothesized that water splits into hydrogen and oxygen during photosynthesis.
- He proposed that the *source of oxygen* released during photosynthesis is *water* and not the  $\text{CO}_2$ .
- *Hydrogen of water* is involved in reducing NADPH to  $\text{NADPH}_2$ .
- $\text{NADPH}_2$  and **ATP** act as *reducing and assimilating powers*, which reduce  $\text{CO}_2$  to form sugar during dark reaction.

CHLOROPLASTS

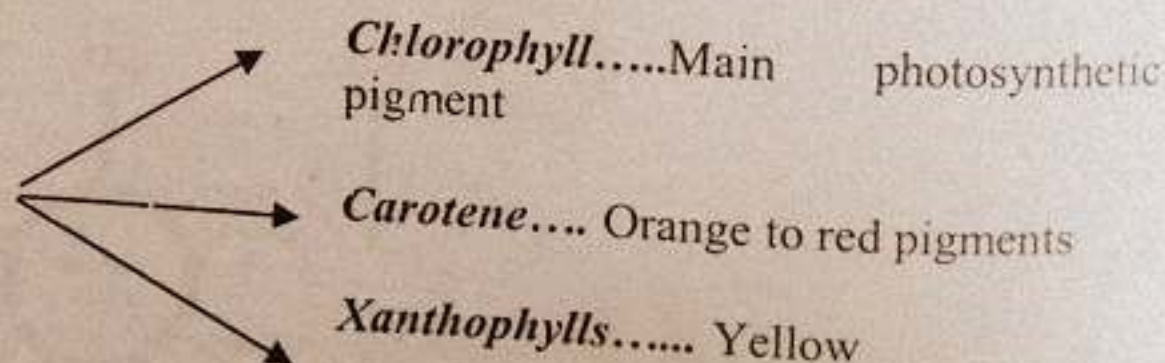
- Present in all the green parts of the plant, with in *mesophyll tissue*.
- Present in very large number, about  $1/2 \text{ million} / \text{mm}^2$  of leaf surface.
- Each mesophyll cell has *20 - 100 chloroplasts*.

Structure

- A surrounding *double membrane*.
- **Stroma** that contains most of the enzymes required to produce CHO molecule.
- **Thylakoids** are sets of elaborated interconnected flat disc like sacs, surrounded by a thylakoid membrane and containing a lumen.
- **Thylakoid membranes** contain chlorophyll and other photosynthetic pigments in embedded form, attached electron carriers of electron transport chain. They are also involved in ATP synthesis by the process of *chemiosmosis*.
- **Grana** are stacks of thylakoid.

PHOTOSYNTHETIC PIGMENTS

- Photosynthetic pigments are the substances that absorb *visible light* (380-750 nm wavelength).
- **Spectrophotometer** is an instrument, which is used to measure the relative abilities of different pigments to absorb different wavelengths of light.
- **Absorption Spectrum** is a graph showing absorption of light of different wavelengths by a pigment.

PHOTOSYNTHETIC PIGMENTSCHLOROPHYLLS

- They are *main photosynthetic pigments of plants*.
- They are *insoluble in water* but are *soluble in organic solvents* like carbon tetrachloride, alcohol etc.



- *Chlorophyll a, b, c, and d* are found in eukaryotic photosynthetic plants and algae.
- *Bacteriochlorophyll* are found in photosynthetic bacteria.
- They mainly *absorb violet- blue and orange – red wavelength* while reflect green, yellow and indigo wavelength.

### Structure

- A chlorophyll molecule has two parts i.e. **hydrophilic head** and a **hydrophobic hydrocarbon tail**.
- *Hydrophilic head* is flat, square, light absorbing, porphyrin ring or tetrapyrrole ring structure containing magnesium as central metal ion, which is coordinated with nitrogen.
- *Hydrophobic hydrocarbon tail* is long, phytol ( $C_{20}H_{39}O$ ), anchoring, hydrophobic and hydrocarbon in nature.

DIFFERENCE	CHLOROPHYLL a	CHLOROPHYLL b
Molecular formula	$C_{55}H_{72}O_5N_4Mg$	$C_{55}H_{70}O_6N_4Mg$
Functional group	$-CH_3$	$-CHO$
Occurrence	All photosynthetic organisms except photosynthetic bacteria	In association with chlorophyll a in all green plants and green algae
Forms	Differ slightly in their red absorbing peaks e.g. 670, 680, 690, 700 nm	No such different forms
Colour	Blue - green	Yellow- Green

### ACCESSORY PIGMENTS

- They absorb strongly the *blue- violet range*.
- *Carotenoids and chlorophyll b* are called accessory pigments, since they absorb light and transfer the energy to chlorophyll a, which then initiate the light reaction.
- Some of these may *protect chlorophyll* by absorbing intense light.
- Similar carotenoids may *protect human eye*.
- Transfer of energy is as under.

Carotenoids  $\longrightarrow$  Chlorophyll b  $\longrightarrow$  Chlorophyll a

### LIGHT - THE DRIVING ENERGY

- *Visible light* includes the radiations most important to life, that range from 380- 750 nm wavelength.
- Only about *1%* of light falling on leaf is *absorbed*, rest is either reflected or transmitted.
- Plot showing relative effectiveness of different wavelengths (colours) of light driving photosynthesis is called *action spectrum*.
- First action spectrum was obtained by German biologist *T.W.Engelmann* in 1883 by working on *spirogyra*.



- About 10 % of photosynthesis is carried by terrestrial plants, while rest occurs in ocean, lakes, and ponds.
- Air contains 0.03 – 0.04 % of CO<sub>2</sub>.
- **Stomata** are adjustable pores that are usually open during the day when CO<sub>2</sub> is required and partially closed at night when photosynthesis stops.
- Daily rhythmic opening and closing of stomata is due to *internal clock* located in the guard cells.
- Stomata cover about 1-2% of the leaf surface area.
- **Aquatic photosynthetic organisms** use dissolved CO<sub>2</sub>, bicarbonates and soluble carbonates present in water.
- CO<sub>2</sub> from Air → Stomata → Air Spaces → Dissolved in Water → Absorbed by Mesophyll cells.

### REACTIONS OF PHOTOSYNTHESIS

- Photosynthesis is a *redox reaction*.
- There are *two types of photosynthetic reactions* i.e. light-dependent reactions & light independent reactions.

### LIGHT-DEPENDENT PHASE

- Such types of reactions, which require light and constitute that phase of photosynthetic reaction during which light energy is absorbed by chlorophyll and other photosynthetic pigment molecules and converted into chemical energy are called light reactions.

#### **Photosystem**

Photosynthetic pigments are organized into clusters called *photosystems*.

- **Antenna complex** has many chlorophyll a, b and carotenoids, which channelize energy to reaction centre.
- **Reaction centre** is constituted by chlorophyll a along with primary electron acceptor and associated electron carriers of electron transport system.
- **Primary electron acceptor** traps the high energy electron from the reaction centre and then passes them on to the series of electron carriers.

#### **Types Of Photosystem**

- **PS I** has chlorophyll a molecule which absorbs maximum light of 700 nm also called as P<sub>700</sub>.
- **PS II** has a form of chlorophyll a molecule which absorbs maximum light of 680 nm and also called as P<sub>680</sub>.

### **NON-CYCLIC PHOTOPHOSPHORYLATION**

- It is more common than cyclic photophosphorylation.
- Non-cyclic phosphorylation is also called *Z-scheme*.
- Splitting of water by light is called *photolysis*.



**Passage Of Electrons**

PS II  $\rightarrow$  Primary Electron Acceptor  $\rightarrow$  Pq  $\rightarrow$  Cytochrome Complex  $\rightarrow$  Pc  $\rightarrow$  PS I  
 Primary Electron Acceptor  $\rightarrow$  Fd  $\rightarrow$  NADP<sup>+</sup>

**End Products Of Light Reaction**

- NADPH/ NADPH<sub>2</sub>
- ATP

**CYCLIC PHOTOPHOSPHORYLATION**

- Occurs at that time when ATP become less and NADPH more for Calvin cycle.

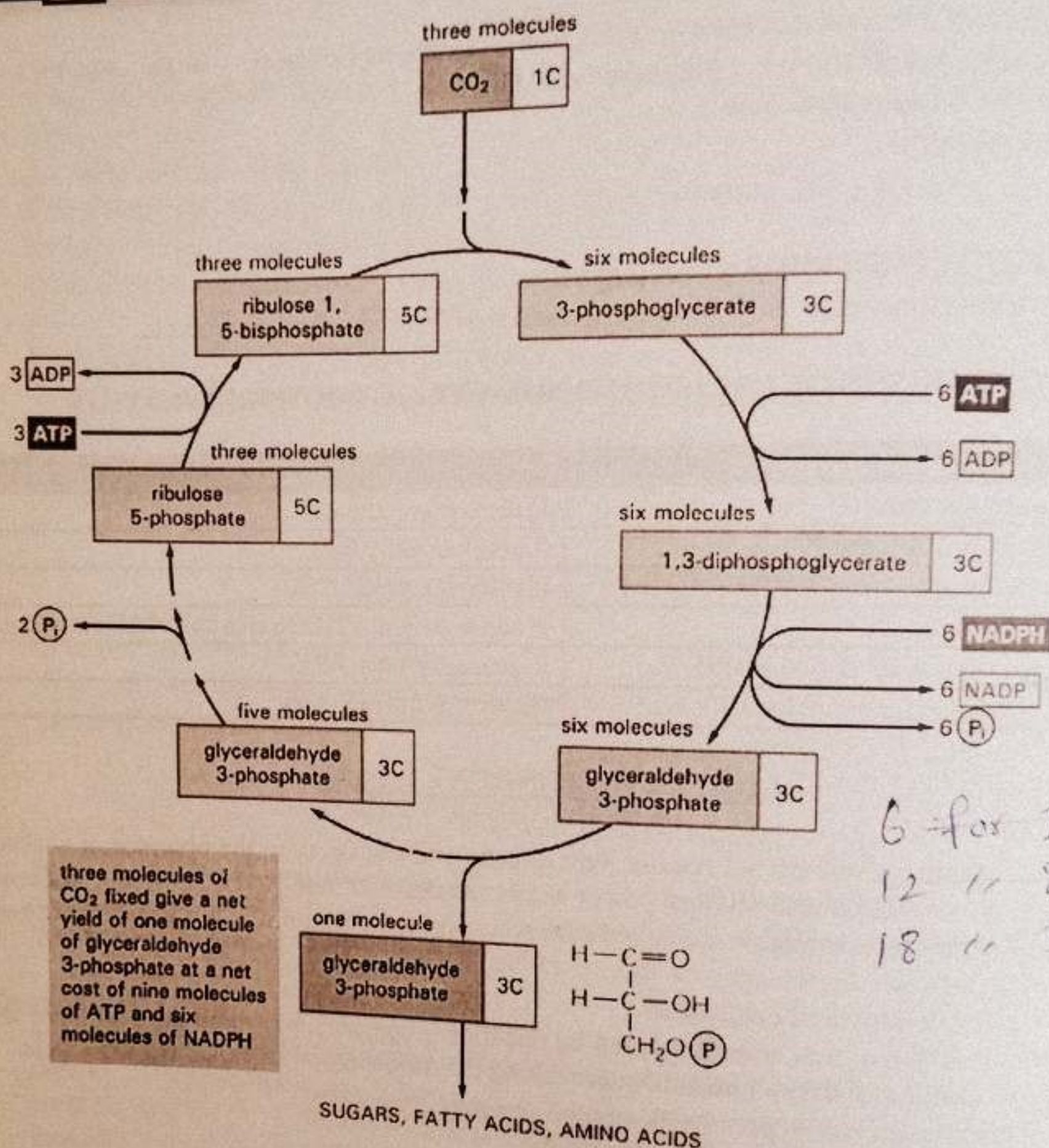
**COMPARISON OF CYCLIC AND NON-CYCLIC PHOSPHORYLATION**

NON-CYCLIC	CYCLIC
Electrons are not reused.	Electrons are reused.
It involves both PS I and II.	It involves only PS I.
It is long pathway.	It is short circuit.
It is normal process.	It occurs when ATP are less and NADPH more.
It generates both ATP and NADPH.	It generates only ATP.
Oxygen is released.	Oxygen is not released.

**LIGHT INDEPENDENT PHASE**

- Those reactions which do not require light directly and can occur in the presence or absence of light provided that assimilatory power in the form of ATP and NADPH, produced during the light reaction is available are called dark reactions and constitute light independent phase of photosynthesis.
- Takes place in stroma of chloroplast.
- The cyclic series of reactions, catalyzed by respiratory enzymes, by which the C is fixed and reduced resulting in the synthesis of sugar during the dark reaction, is called Calvin Cycle.
- It is divided into three steps:
  - **Carbon fixation**
  - **Reduction**
  - **Regeneration of CO<sub>2</sub> acceptor.**
- CO<sub>2</sub> fixation is dependent on ribulose biphosphate carboxylase (*Rubisco*).
- Rubisco is most abundant protein in chloroplast and on earth.





### COMPARISON OF LIGHT AND DARK REACTIONS

Light Reaction	Dark Reaction
Occur in grana of chloroplast.	Occurs in matrix of chloroplast.
Light is required	Light is not required.
O <sub>2</sub> ATP and NADPH <sub>2</sub> are the end products.	In Calvin cycle, ATP and NADPH <sub>2</sub> are used to prepare carbohydrates.





1. Quantitative study of energy relationships in biological systems is called \_\_\_\_\_.
2. \_\_\_\_\_ is a kind of chemical linkage between catabolism and anabolism.
3. \_\_\_\_\_ appears on both sides of photosynthetic equation.
4. Each mesophyll cell has \_\_\_\_\_ chloroplast.
5. Accessory pigments in plants absorb strongly the \_\_\_\_\_.
6. Photosynthetic pigments are organized into clusters called \_\_\_\_\_.
7. Light independent phase takes place in \_\_\_\_\_ of chloroplast.

### RESPIRATION

- Respiration is a universal process by which organisms break complex compounds containing carbon in a way that allows the cell to harvest a maximum of usable energy.
- Exchange of gases ( $O_2$  &  $CO_2$ ) is called *external respiration*.
- Oxidation of food is *internal respiration*.

#### Cellular Respiration

- A process by which energy is made available to cells in a step by step breakdown of C- chain molecules in the cell is called *cellular respiration*.
- Cellular respiration is an *oxidation process*.
- It is subdivided into *four stages*.

No.	STAGE	LOCATION
1	Glycolysis	Cytosle
2	Pyruvic acid oxidation	Mitochondrion
3	Kreb's cycle	Mitochondrion
4	Respiratory chain	Mitochondrion

#### Types Of Respiration

- Such type of respiration in which oxygen is used is called *aerobic respiration*.
- Such type of respiration, which takes place in the absence of molecular oxygen, is called *anaerobic respiration*.

Answers: (1) Bioenergetics (2) ATP (3) Water (4) 20 - 100 (5) Blue-Violet (6) Photosystem (7) Stroma





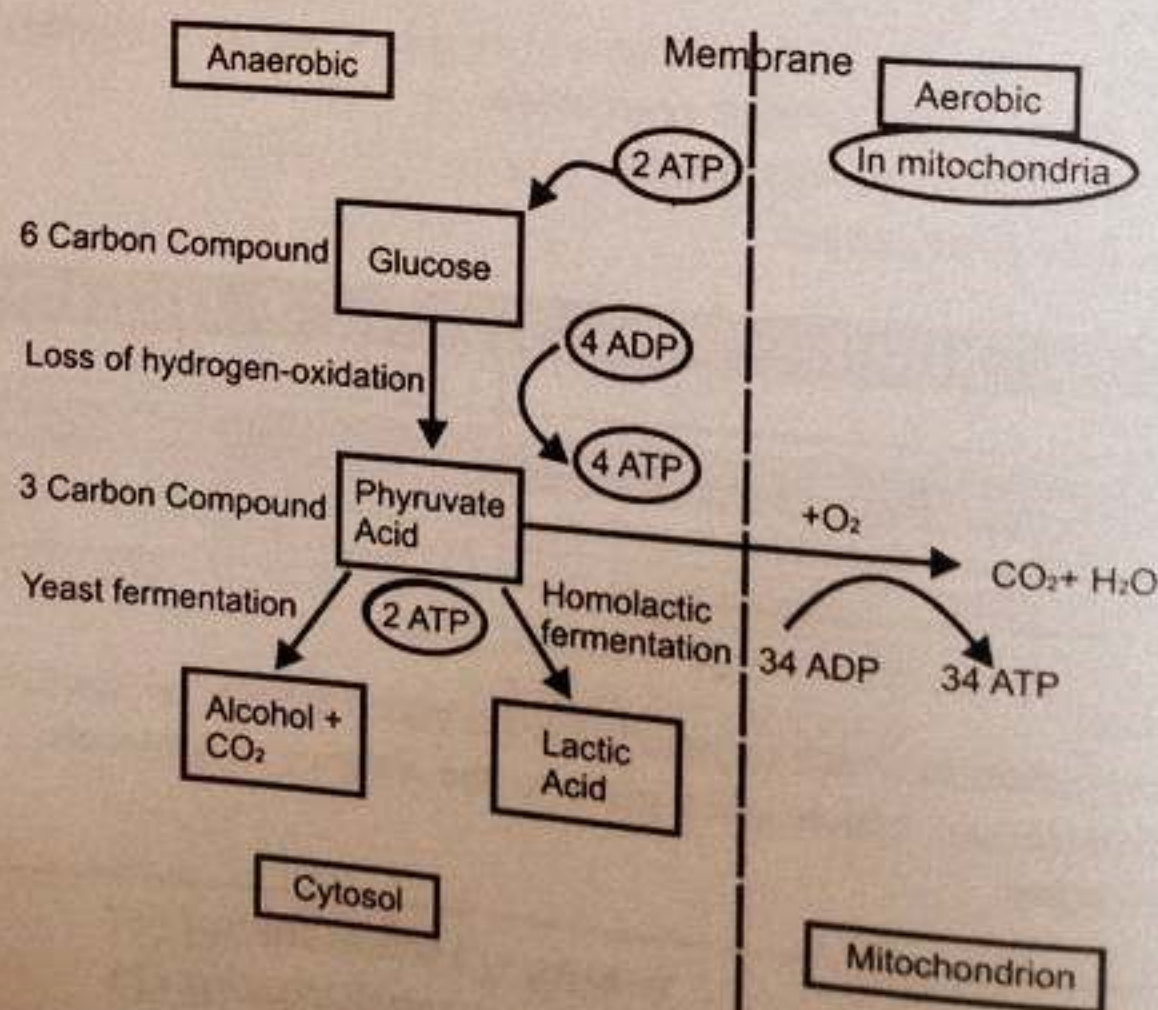
- Anaerobic respiration is also called *fermentation*.
- *Anaerobic respiration* yield only a small amount of energy from glucose molecule, e.g., only 2% of the energy present within the chemical bond of glucose is converted in to ATP.

AEROBIC RESPIRATION	ANAEROBIC RESPIRATION
<ul style="list-style-type: none"> <li>• Free <math>O_2</math> is required.</li> <li>• Glucose is completely oxidized into <math>CO_2</math> and <math>H_2O</math></li> <li>• Relatively larger amount of energy (38ATP) is released.</li> <li>• In addition to glycolysis, Kreb's cycle and ETC also occur.</li> </ul>	<ul style="list-style-type: none"> <li>• Reaction occurs in the absence of free <math>O_2</math></li> <li>• Some intermediate compounds are formed due to incomplete oxidation e.g lactic acid and alcohol etc.</li> <li>• Small amount of energy is formed (2ATP).</li> <li>• Only glycolysis occurs.</li> </ul>

- **Mitochondria** are the *power houses* of the cell that provide energy necessary for many cellular functions.

### ATP

- ATP has a key role in most biological energy transformations.
- The **2<sup>nd</sup> and the 3<sup>rd</sup> phosphate bonds** in ATP molecule represent high energy bonds.
- Breaking of **terminal phosphate** of ATP releases about **7.3 KCal of energy**.
- These high energy phosphate bonds enables the cell to accumulate a great quantity of energy in a very small space and keeps it ready for use as soon as it is needed.





# Chapter 11 Bioenergetics

## AEROBIC RESPIRATION

### GLYCOLYSIS

- Its meaning is *splitting of sugar*.
- It is generally break down of one glucose molecule into two molecules of pyruvic acid.
- It occurs in *cytoplasm*.
- May take place in the absence (*Anaerobic*) or in the presence of  $O_2$  (*Aerobic* conditions).
- Enzymes, ATP, and Coenzyme NAD (nicotinamide adenine dinucleotide) are essential for glucolysis.
- There are *two phases* of glycolysis i.e. *preparatory phase* (breakdown of glucose, utilization of ATP) & *oxidative phase* (formation of ATP).

### PYRUVIC ACID OXIDATION

- It uses end product of glycolysis.
- It converts 3-C pyruvate into 2-C acetate and then converts into *active acetate* (acetyl CoA)

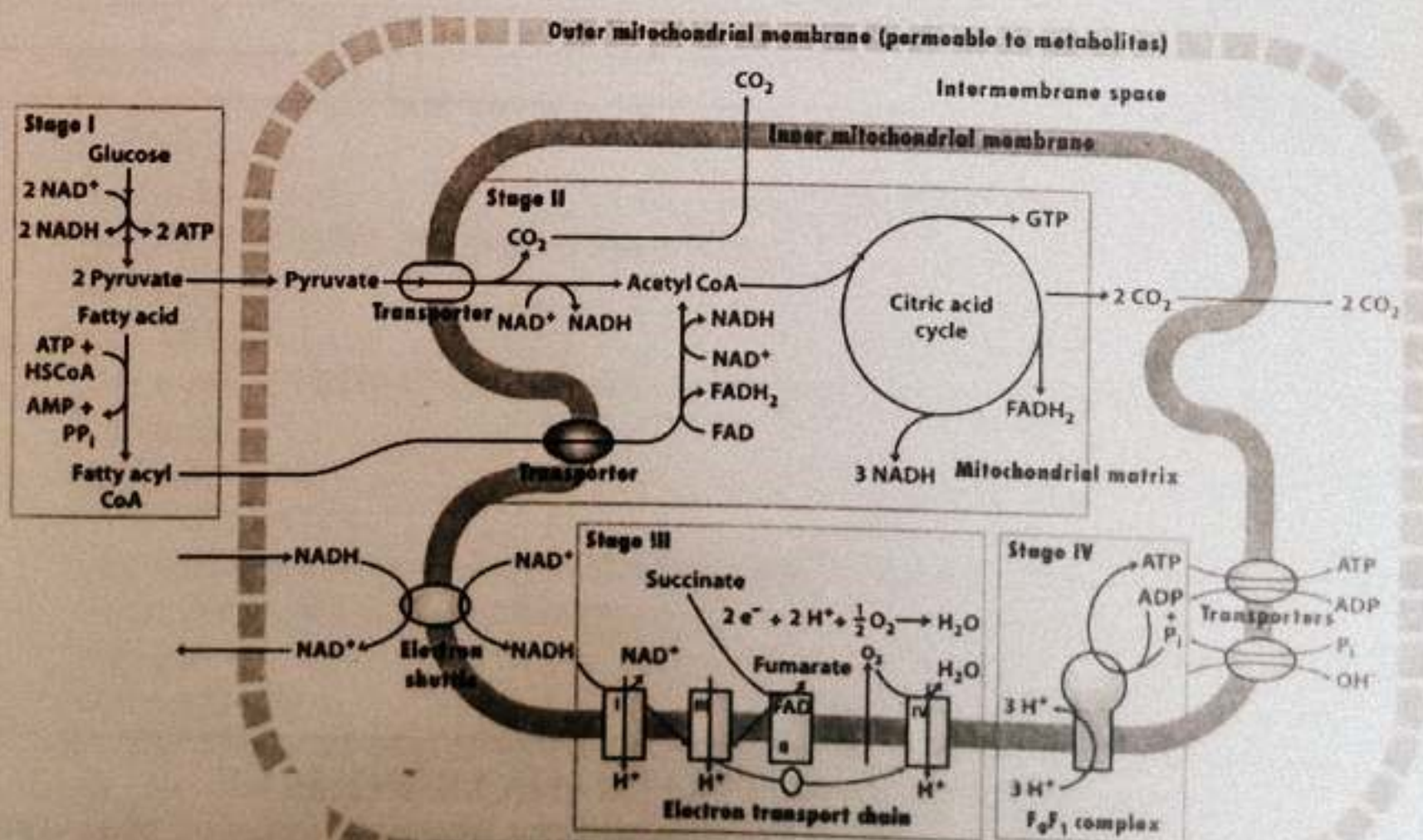
### KREB'S CYCLE

- It is also called *citric acid cycle*.
- *Sequence of reactions* is as

Acetyl CoA + Oxaloacetate  $\rightarrow$  Citrate  $\rightarrow$  Isocitrate  $\rightarrow$   $\alpha$ -ketoglutarate  $\rightarrow$  succinate  $\rightarrow$  Fumarate  $\rightarrow$  Malate  $\rightarrow$  Oxaloacetate

### ELECTRON TRANSPORT CHAIN

- A system where electrons are transported in a series of oxidation- reduction steps to react ultimately, with molecular oxygen is called *electron transport system or respiratory chain*.
- *Sequence of electron flow* is as follows:  
Coenzyme Q  $\rightarrow$  Cytochrome b  $\rightarrow$  Cytochrome c  $\rightarrow$  Cytochrome a  $\rightarrow$  Cytochrome  $a_3$
- Synthesis of ATP in the presence of  $O_2$  is called *oxidative phosphorylation*.







1. Exchange of gases ( $O_2$  &  $CO_2$ ) is called \_\_\_\_\_.
2. Cellular respiration is a/ an \_\_\_\_\_ process.
3. Breaking of terminal phosphate of ATP releases about \_\_\_\_\_ KCal of energy.
4. Pyruvic acid oxidation uses end product of \_\_\_\_\_ phase.
5. \_\_\_\_\_ is also called citric acid cycle.
6. Synthesis of ATP in the presence of  $O_2$  is called \_\_\_\_\_.

----- VALUES -----

Property	Value
Number of chloroplast in a mesophyll cell	20-100
Range of wavelength of visible light	380-750 nm
Amount of $CO_2$ in air	0.03-0.04%
Amount of energy available to form ATP from glucose during anaerobic respiration	2%
Amount of energy released from breaking terminal phosphate of ATP	7.3 Kcal
Total production of ATP during glycolysis	4 ATP
Net production of ATP during glycolysis	2 ATP
Area occupied by stomata on leaf	1-2%

Answers:  
(1) External Respiration (2) Oxidation (3) 7.3 (4) Glycolysis  
(5) Krebs's Cycle (6) Oxidative Phosphorylation





## PRACTICE EXERCISE

 40 mins  
Time Yourself

- Which of the following is a chemical link between catabolism and anabolism?  
 (a) AMP (b) ADP  
 (c) ATP (d) All of these
- Photosynthesis is process in which \_\_\_\_\_ compounds of carbon ( $\text{CO}_2$ ) and hydrogen ( $\text{H}_2\text{O}$ ) are reduced to carbohydrate like (glucose) using light energy.  
 (a) Organic (b) Energy rich  
 (c) Energy poor (d) Reduced
- $\text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 \rightarrow 6\text{CO}_2 + 6\text{H}_2\text{O} + \text{ENERGY}$  represents:  
 (a) Photosynthesis. (b) Aerobic respiration.  
 (c) Anaerobic respiration. (d) Respiration.
- At which times there is no net gaseous exchange between leaves and the atmosphere.  
 (a) Day time. (b) Night time.  
 (c) Dawn & Dusk. (d) Mid night.
- Which of the following is a compensation point:  
 (a) Leaves respire and utilize  $\text{O}_2$  and release  $\text{CO}_2$ .  
 (b) Photosynthesis and respiration occur at same rate. So there is not net exchange of gases between atmosphere and plants.  
 (c) Rate of photosynthesis increases, so do the  $\text{O}_2$  production, with a net release of oxygen coupled with the uptake of  $\text{CO}_2$ .  
 (d) Rate of respiration becomes more than rate of photosynthesis.
- Quantitative study of energy relationships in biological systems obeys  
 (a) Bioenergetics (b) Laws of thermodynamics  
 (c) Laws of thermo chemistry (d) Laws of chemical energetic
- The organisms able to use sunlight directly as a source of energy are  
 (a) Plants (b) Animals  
 (c) Omnivores (d) Fungi
- Of the following which one is not an energy releasing process?  
 (a) Glycolysis (b) Respiration  
 (c) Photosynthesis (d) Kreb's cycle
- Net yield of  $\text{H}_2\text{O}$  in Photosynthesis is  
 (a) 1 molecule (b) 6 molecules  
 (c) 3 molecules (d) 0 molecule
- The point at which there is no net exchange of gases between leaves and atmosphere is known as  
 (a) Neutral point (b) Compensation point  
 (c) Parallel point (d) Competitive point
- Van Neil hypothesis about the production of oxygen during photosynthesis was based on the study and investigations on  
 (a) Bacteria (b) Algae  
 (c) Protonema (d) Cyanobacteria
- Visible light used in photosynthesis ranges from:  
 (a) 300 – 700 nm in wavelength. (b) 350 - 750 nm in wavelength.  
 (c) 380- 750 nm in wavelength. (d) 390- 790 nm in wavelength.





13. Which of the following light is least absorbed by the plants:  
 (a) Orange (b) Red  
 (c) Blue (d) Green
14. Which of the light is mainly absorbed by the plants:  
 (a) Orange (b) Red  
 (c) Green (d) Both A and B
15. Chlorophyll is insoluble in:  
 (a) Carbon tetrachloride (b) Alcohol  
 (c) Organic solvents (d) Water
16. Which of the following statement about the head of a chlorophyll molecule is incorrect:  
 (a) It is a porphyrin ring or tetrapyrrole ring structure  
 (b) It is flat, square and light absorbing  
 (c) Composed of carbon and nitrogen atoms with *Magnesium* as central metal ion, which is coordinated with nitrogen.  
 (d) It is hydrophobic
17. Molecular formula of chlorophyll 'a' molecule is:  
 (a)  $C_{55}H_{72}O_5N_4Mg$  (b)  $C_{55}H_{70}O_6N_4Mg$   
 (c)  $C_{50}H_{72}O_6N_4Mg$  (d)  $C_{55}H_{70}O_5N_4Mg$
18. Which of the following pigment is Blue- green in colour:  
 (a) Chlorophyll a (b) Chlorophyll b.  
 (c) Chlorophyll c (d) Chlorophyll d.
19. Which is the correct order of energy transfer from accessory pigments to main photosynthetic pigment?  
 (a) Carotenoids  $\rightarrow$  Chlorophyll a  $\rightarrow$  Chlorophyll b.  
 (b) Chlorophyll b  $\rightarrow$  Carotenoids  $\rightarrow$  Chlorophyll a.  
 (c) Carotenoids  $\rightarrow$  Chlorophyll b  $\rightarrow$  Chlorophyll a.  
 (d) Chlorophyll a  $\rightarrow$  Chlorophyll b  $\rightarrow$  Carotenoids.
20. Light reaction takes place on/in  
 (a) Thylakoid (b) Stroma  
 (c) Chloroplast (d) Grana
21. Thylakoids in chloroplasts are stacked into  
 (a) Grana (b) Stroma  
 (c) Nucleus (d) None of these
22. In all plants the major sites of photosynthesis are  
 (a) Leaves (b) Stems  
 (c) Roots (d) Branches
23. The dense fluid filled region in the chloroplast is  
 (a) Grana (b) Stroma  
 (c) Thylakoid (d) None of these
24. Chlorophylls are found embedded in the \_\_\_\_\_ membranes  
 (a) Stroma (b) Grana  
 (c) Thylakoid (d) Intergrana
25. Xanthophylls are \_\_\_\_\_ pigments  
 (a) Yellow (b) Red  
 (c) Orange (d) Green



26. Chlorophylls mainly absorb \_\_\_\_ wavelengths
  - (a) Orange – blue
  - (b) Violet – red
  - (c) Yellow – orange
  - (d) Orange – red.
27. Deficiency of \_\_\_\_ causes yellowing in plants
  - (a) Magnesium
  - (b) Iron
  - (c) Chlorine
  - (d) Oxygen
28. The chlorophyll molecule is embedded in the core of thylakoid membrane which acts as
  - (a) Hydrophilic
  - (b) Hydrophobic
  - (c) Both of these
  - (d) None of these
29. The most important photosynthetic pigment
  - (a) Chlorophyll a
  - (b) Chlorophyll b
  - (c) Xanthophyll
  - (d) Carotenes
30. Bacteriochlorophylls does not include
  - (a) Chlorophyll e
  - (b) Chlorophyll d
  - (c) Chlorophyll a
  - (d) Chlorophyll c
31. Molecular formula of chlorophyll b is
  - (a)  $C_{55}H_{10}O_4N_6Mg$
  - (b)  $C_{55}H_{70}O_6N_5Mg$
  - (c)  $C_{55}H_{71}O_6N_4Mg$
  - (d)  $C_{55}H_{70}O_6N_4Mg$ .
32. Carotenoids perform protective function in
  - (a) Animals
  - (b) Plants
  - (c) Both of these
  - (d) None of these
33. About \_\_\_\_% of photosynthesis is carried by terrestrial plants, while rest occurs in ocean, lakes, and ponds.
  - (a) 10 %
  - (b) 20 %
  - (c) 30 %
  - (d) 40 %
34. Air contains \_\_\_\_% of  $CO_2$ 
  - (a) 0.02 – 0.03
  - (b) 0.03 – 0.04
  - (c) 0.04 – 0.05
  - (d) 0.05 – 0.06
35. PS I has chlorophyll a molecule which absorbs maximum light of \_\_\_\_ nm.
  - (a) 600
  - (b) 650
  - (c) 680
  - (d) 700
36. The percentage of light absorbed by the leaf
  - (a) 20%
  - (b) 15%
  - (c) 10%
  - (d) 1%
37. The first action spectrum was obtained by
  - (a) T.W.Englemam
  - (b) Malleus
  - (c) T.W.Inws
  - (d) W.Stapes
38. First Actions spectrum was obtained by using
  - (a) Algae
  - (b) Fungi
  - (c) Bacteria
  - (d) Spirogyra
39. Of the following, which one causes higher production of food in green plants
  - (a) Blue
  - (b) Orange
  - (c) Red
  - (d) Violet
40. Photosynthesis carried out by terrestrial plants is \_\_\_\_ of total photosynthesis.
  - (a) 1-2%
  - (b) 5%
  - (c) 10%
  - (d) 20%





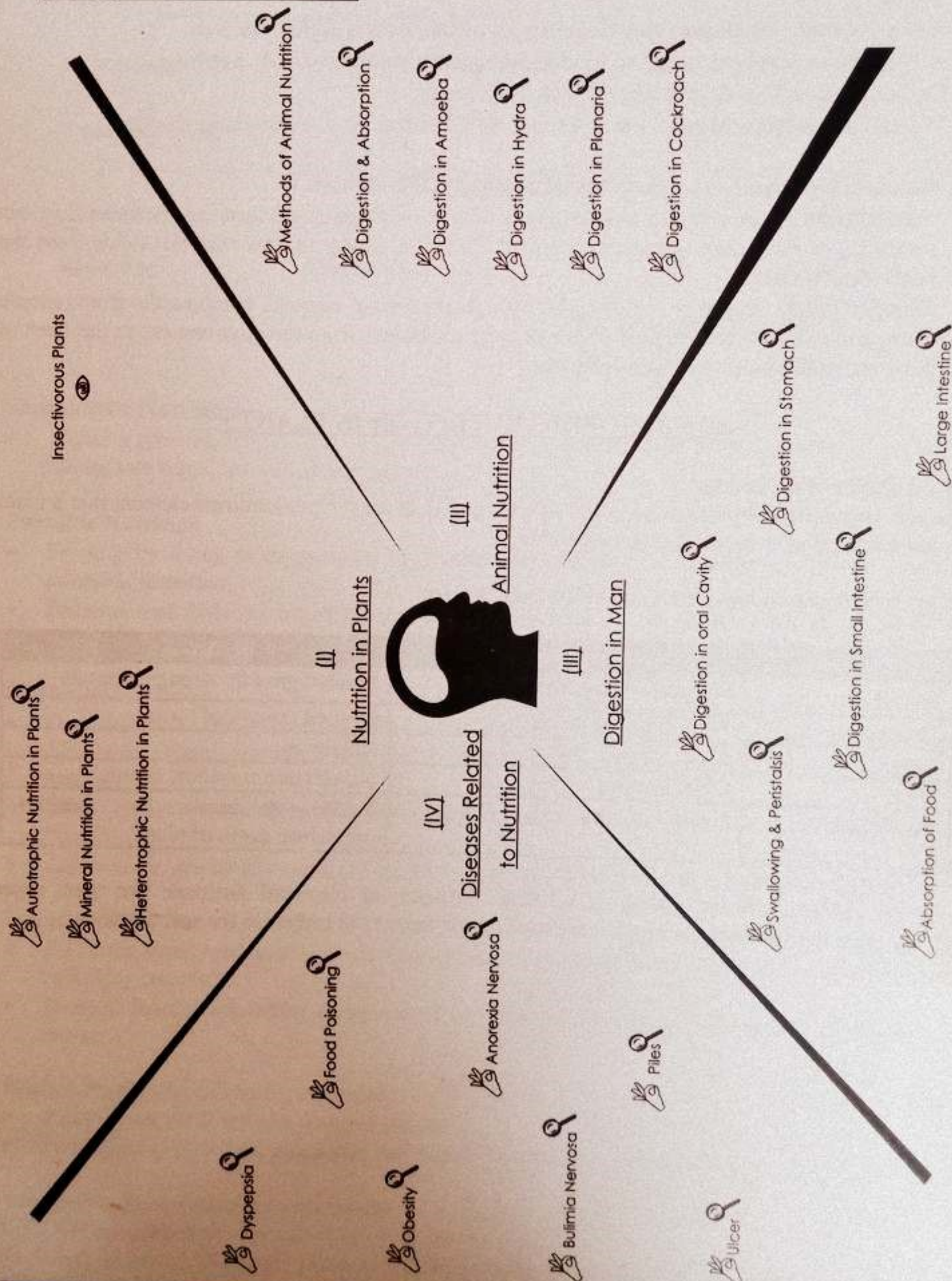
41. Stomata cover only \_\_\_\_\_ of leaf surface.  
 (a) 0.03-0.04 % (b) 10 %  
 (c) 1-2 % (d) 50 %
42. Reduction in photosynthesis is of  
 (a)  $O_2$  (b)  $CO_2$   
 (c)  $H_2O$  (d) light energy
43.  $NADPH_2$  provides  
 (a) assimilatory power (b) chemical energy  
 (c) energized electrons (d) All of these
44. Of the following, which one is light-gathering  
 (a) Antenna complex (b) Reaction centre  
 (c) Photosystem (d) None of these
45. Photosystem II has molecules which absorb maximum light of  
 (a) 680 nm (b) 100 m  
 (c) 700 nm (d) 670 nm
46. Glycolysis takes place in:  
 (a) Nucleus (b) Cytosol  
 (c) Mitochondria (d) Ribosomes
47. Complete breakdown of glucose molecule takes place in which of the following:  
 (a) Alcoholic fermentation. (b) Lactic acid fermentation.  
 (c) Aerobic respiration. (d) All of these
48. In alcoholic fermentation Pyruvic acid is broken down into:  
 (a) Acetaldehyde (b) Methyl alcohol.  
 (c) Ethyl alcohol. (d) Lactic acid.
49. In which of the following component of the body, lactic acid fermentation takes place:  
 (a) Brain. (b) Heart  
 (c) Liver. (d) Muscles
50. In Anaerobic respiration only \_\_\_\_\_ % of the energy present within the chemical bond of glucose is converted into ATP.  
 (a) 1% (b) 2%  
 (c) 3% (d) 4%
51. Cellular respiration is essentially a/an \_\_\_\_\_ process.  
 (a) Oxidation. (b) Reduction.  
 (c) Redox. (d) None of the above.
52. Breaking of terminal phosphate of ATP releases about \_\_\_\_\_ Kcal of energy.  
 (a) 6.1 (b) 6.3  
 (c) 7.1 (d) 7.3
53. ATP are consumed during  
 (a) Glycolysis (b) Krebs's cycle  
 (c) Light dependent phase (d) None of these
54. From one pyruvate passing through Krebs's cycle, how many NADH are formed?  
 (a) 1 (b) 2  
 (c) 3 (d) 4
55. Final acceptor of electrons in respiratory chain is  
 (a) NADH (b) Cytochrome  $a_3$   
 (c) Water (d) Oxygen





# Chapter 12

## NUTRITION







### INTRODUCTION

- Any substance, which provides elements for metabolism is called *nutrient*.
- All processes involved in taking food in and its utilization constitute nutrition.
- Carbohydrates, Fats & Proteins → Provides energy.
- Water, Electrolytes, Minerals & Vitamins → Essential To The Metabolic Process.

#### Division Of Organisms On The Basis Of Methods Of Nutrition

- **Autotrophic** organisms can exist in an exclusively inorganic environment because they can manufacture their own organic compounds from the inorganic raw material taken from the surrounding media.
- **Heterotrophic** organisms incapable of manufacturing organic compounds from simple inorganic nutrients and so they obtain organic molecules from the environment in the form of food are called heterotrophic organisms.

### AUTOTROPHIC NUTRITION IN PLANTS

#### Mineral Nutrition In Plants

Carbon, oxygen and hydrogen supplied by  $\text{CO}_2$  and  $\text{H}_2\text{O}$  are the predominant element that a plant needs for the synthesis of organic molecules.

#### Mineral Requirements Of Plants With Deficiencies

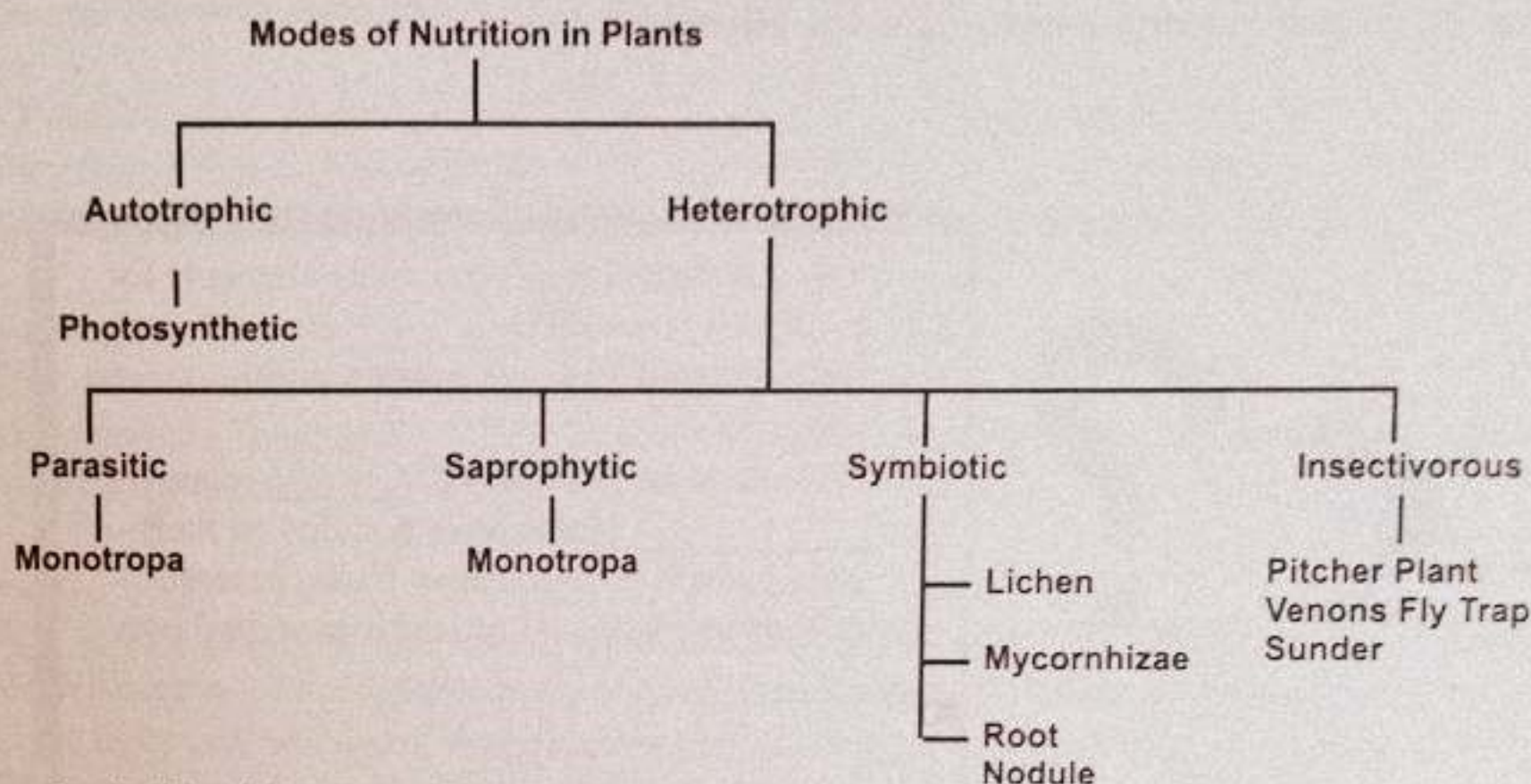
Element	Occurrence	Deficiency
Nitrogen	Protein, Chlorophyll	Stunted growth, strong chlorosis
Phosphorous	ATP, Nucleic Acids	Stunted growth of roots
Magnesium	Chlorophyll	Chlorosis
Iron	Cytochromes	No electron transport chains
Potassium	Healthy leaves	Yellow & brown leaf margins, premature death of plant

Animal manure, sewage sludge or artificial fertilizer, or chemical fertilizer like urea, super phosphates, and ammonium nitrates are used by the farmers to replenish the soil nutrients.





### HETEROTROPHIC NUTRITION IN PLANTS



#### **Saprophytic Nutrition**

- Those organisms, which feed on dead and decaying matter such as dead leaves in the soil or rotting tree trunk, are called saprophytes.

#### **Parasitic Nutrition**

- Feeding by living in or on other organisms (host) belonging to different species is called **parasitic nutrition**.
- Puccinia that destroys wheat plant and Dodder (*Cuscuta* – Leafless plant) are examples of **parasitic plants**.

#### **Symbiotic Nutrition**

- Two different organisms belonging to two different species living in a mutual association with one another, in such a way that both get benefit from each other is called symbiotic nutrition.
- Some important examples are **lichen**, **mycorrhizae** and root nodules with nitrogen fixing bacteria.
- Leguminous plants** have nodules on their roots, which have nitrogen fixing bacteria.

#### **Insectivorous Plants**

- All of the insectivorous plants are true autotrophs but they fulfill their nitrogen requirements by killing insects.
- Trapped insects are either decomposed by **bacteria** or digested by **enzymes** secreted by leaves.

#### **Pitcher Plants (*Sarracenia purpurea*)**

- It has leaves modified into a **sac or pitcher**.
- End of leaf is modified into **hood**, which partly covers the open mouth of pitcher.

#### **Venus-Fly Trap (*Dionaea muscipula*)**

- The leaf is **lobed** with midrib between them.
- There is row of long **stiff bristles** along the margins of each lobe that trap insects.





### Sundew (*Drosera intermedia*)

The tiny leaves bear numerous sticky hairs like *tentacles*.



1. Any substance, which provides elements for metabolism is called \_\_\_\_\_.
2. Deficiency of \_\_\_\_\_ causes strong chlorosis.
3. *Cuscuta* is an example of \_\_\_\_\_ plant.
4. \_\_\_\_\_ plants have nodules on their roots, which have nitrogen fixing bacteria.
5. In Pitcher plant, end of leaf is modified into \_\_\_\_\_.

## METHODS OF ANIMAL NUTRITION

Animals have more variety of nutrition than plants.

### Detritivores

- Animals that feed on detritus are called detritivores.
- **Detritus** is organic debris decomposing plants and animals.
- **Earthworm** is common example.

### Herbivores

- In herbivore mammals, premolars and molars are large and canines and upper incisors are missing.
- **Common examples** are insects, reptiles, birds, mammals including rodents and ungulates.

### Carnivores

- Carnivores have **large canines**.
- Incisors, premolar and molars are all adapted for cutting flesh and cracking bones.
- **Predator** is animal, which captures and readily kills live animals for food. The animal, which is killed, is prey.
- **Common examples** are cats, dogs, lion etc.

### Omnivores

- They eat both plants and animals.
- Teeth of omnivores are structurally and functionally intermediate between herbivores and carnivores.
- **Common examples** are crows, rats, red fox, bears, pigs and man.

(1) Nutrient (2) Nitrogen (3) Parasitic (4) Leguminous (5) Hood



**Filter Feeders**

*Whales* and *common mussels* are filter feeders.

**Fluid Feeders**

- They ingest food in *liquid form*.
- *Aphid* (Phloem feeder) and *mosquitoes* (blood feeder) are common examples.

**Macrophagous Feeders**

- They take in food in form of *large pieces*.
- Macrophagus feeding may be *tentacular* (hydra), *scraping* (garden snail) and *seizing* or swallowing (spotted dogfish).

**Parasites**

- Flea & lice (birds & mammals), ticks & mites (non-human mammals), aphid (plants) and leech (mammals) are *ectoparasites* as they remain on outer surface of body of host.
- Liver fluke and tapeworm are *endoparasites* as they get into the body.
- *Obligate parasites* are totally dependent on host.
- *Facultative parasites* are partially dependent on their host.

GROUP	EXAMPLES
Detritivores	Earthworm
Herbivores	Insects, reptiles, birds, mammals including rodents and ungulates
Carnivores	Cats, dogs, lion
Omnivores	Crows, rats, red fox, bears, pigs and man
Filter Feeders	Whales and common mussels
Fluid Feeders	Aphid (Phloem feeder) and mosquitoes (blood feeder)
Macrophagous Feeders (Tentacular)	Hydra
Macrophagous Feeders (Scraping)	Garden snail
Macrophagous Feeders (Seizing)	Spotted dogfish
Ectoparasite	Flea & lice (birds & mammals), ticks & mites (non-human mammals), aphid (plants) and leech (mammals)
Endoparasite	Liver fluke and tape worm

**DIGESTION AND ABSORPTION**

- Nutrition of solid nutrients is called *holozoic nutrition*.
- Intake of food is called *ingestion*.
- Breakdown of complex organic compounds of food into simpler forms by enzymes is called *digestion*.
- Utilization of products of digestion for energy production or synthesis of materials is called *assimilation*.
- Elimination of undigested food particles is called *egestion*.





### DIGESTION IN AMOEBA

- It has *intracellular* mode of digestion.
- During digestion, *food vacuole* first grows smaller, then larger and again smaller.
- Medium of food vacuole is first acidic (*pH 5.6*) for killing of organism and then alkaline (*pH 7.3*) for digestion.

### DIGESTION OF HYDRA

- Hydra has *vase-like body*.
- It has *gastrovascular cavity* or coelenteron.
- Hydra mainly feeds on *crustaceans* e.g. Daphnia or Cyclops.
- Hydra has *sac-like digestive system*.

### DIGESTION IN PLANARIA

- In planaria, there are *both intracellular and extracellular digestion* at equal level.
- *Ingestion* in planaria is by pharynx.

### COCKROACH

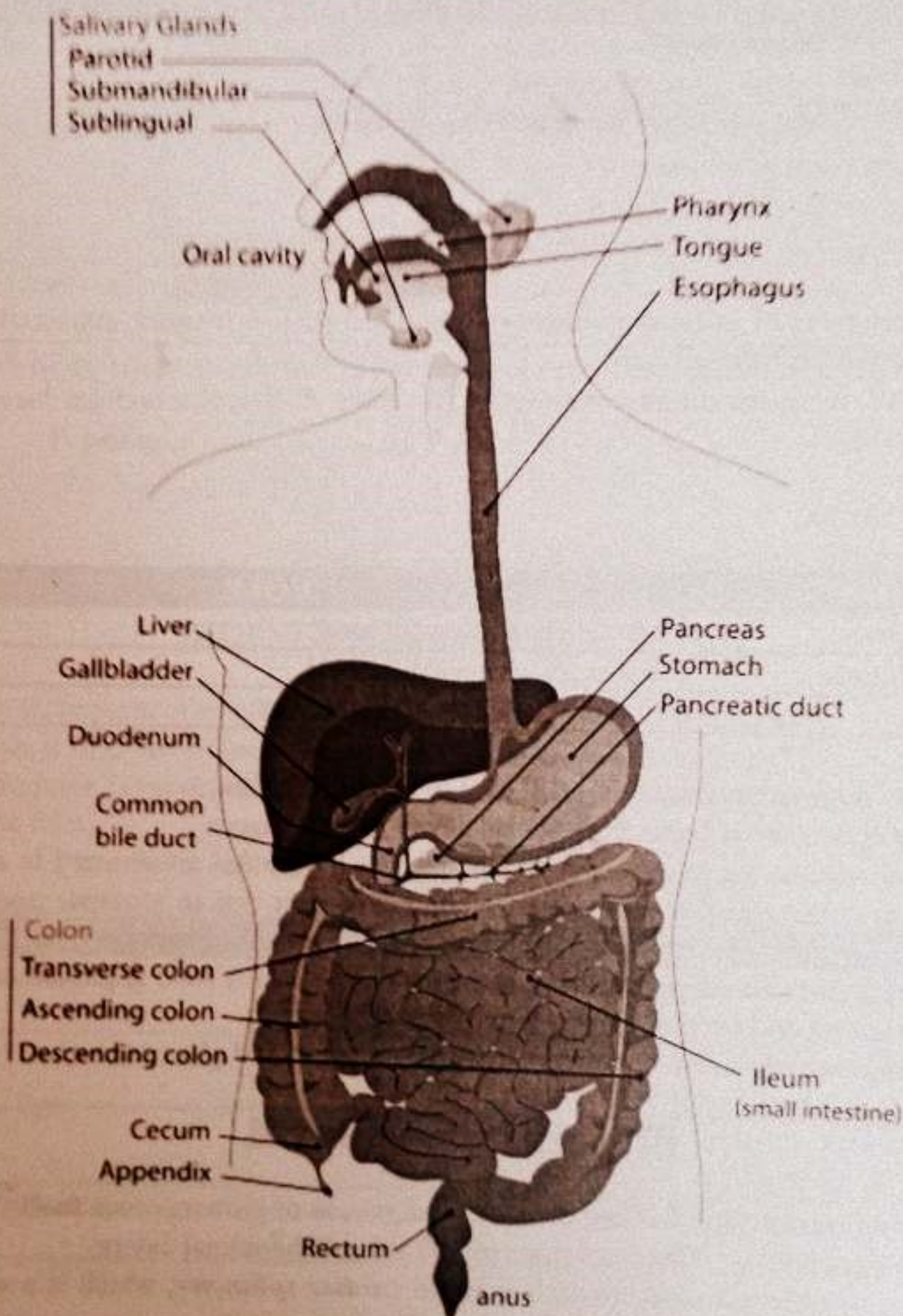
- It feeds on all types of food.
- Digestive system of cockroach is divided into three parts i.e. *foregut* (buccal cavity, pharynx, crop, gizzard), *midgut* (stomach) and *hindgut* (rectum).
- A pair of salivary glands is present in the thorax region of cockroach.
- Midgut is short, narrow tube called mesenteron or stomach.
- *Hepatic caecae* pour their secretions in midgut, where complete digestion of food occurs.
- Cockroach feeds on *all types of food*.
- Crop is involved in storing food.



1. Animals that feed on detritus are called \_\_\_\_\_.
2. \_\_\_\_\_ is animal, which captures and readily kills live animals for food.
3. \_\_\_\_\_ parasites are totally dependent on host.
4. Elimination of undigested food particles is called \_\_\_\_\_.
5. Hydra has \_\_\_\_\_ like body.
6. Ingestion in *Planaria* is by \_\_\_\_\_.
7. A pair of salivary glands is present in the \_\_\_\_\_ region of cockroach.

Answers: (1) Detritivores (2) Predator (3) Obligate (4) Egestion (5) Vase (6) Pharynx (7) Thorax



DIGESTION IN MAN

- Digestive system of a man consists of structures extending from oral cavity to anus, including oral cavity, oesophagus, stomach, small intestine (duodenum, jejunum, and ileum) and large intestine (caecum, ascending colon, transverse and descending colon, and rectum).
- Associated glands like salivary glands, liver and pancreas are also component of digestive system.
- Digestion occurs at three sites:
  - Oral cavity.
  - Stomach
  - Small intestine.



## DIGESTION IN ORAL CAVITY

It performs four important functions:

- Selection of food.
- Grinding or mastication. (Molars are involved in grinding.)
- Lubrication.
- Digestion.

### Salivary Glands

- There are three pairs of *salivary glands* i.e. sublingual (below tongue), submaxillary (behind jaws) and parotid (in front of ears).
- *Saliva* consists three important components i.e. water & mucous, sodium bicarbonate and amylase (ptyalin).

### Components of Saliva

COMPONENT	ROLE
Water and mucous	Moisten and lubricate food
Sodium bicarbonate	Antiseptic and stabilizes pH
Ptyalin	Carbohydrate digesting enzyme

- End result of digestion in mouth is small oval lump called **bolus**.
- *Swallowing* is transfer of bolus from buccal cavity to oesophagus.
- Beginning of swallowing is voluntary action and then it becomes involuntary.
- *Peristalsis* are characteristic movements of digestive tract due to alternate contraction and relaxation of smooth muscles by which food is pushed along the digestive tract.
- *Antiperistalsis* are reverse peristaltic movements due to which food is passed from intestine back into stomach and even in mouth. It may lead to vomiting.
- *Hunger pangs* are peristaltic contractions caused by low blood glucose level.

## DIGESTION IN STOMACH

- Stomach is an elastic muscular bag involved in digestion of proteinaceous food.
- Stomach is situated below the diaphragm on left side of abdominal cavity.
- Point where oesophagus joins stomach is called *cardiac sphincter*, which is a special closed ring of contracted muscles.
- Point where stomach joins intestine is called *pyloric sphincter*.
- **Stomach wall** is composed of three principal *layers* i.e. outer layer of connective tissue, middle layer of smooth muscles and inner layer (mucosa) of connective tissue with many glands.

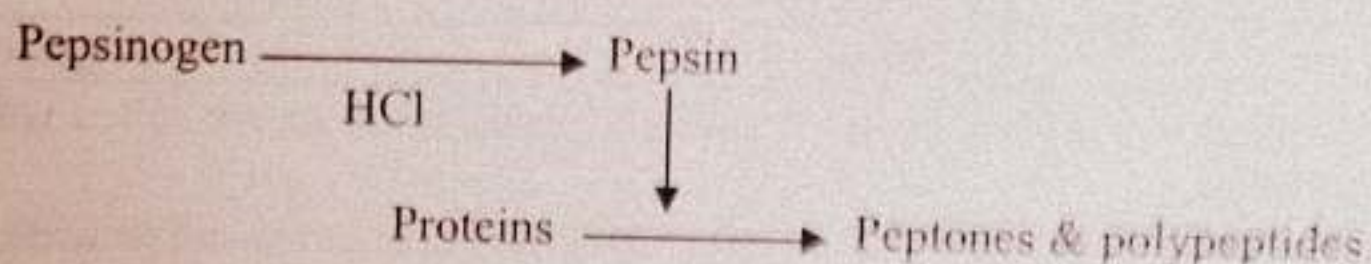




## Cells of Gastric Glands

CELL	SECRETION	FUNCTION
Mucous cell	Thick Mucous	<ul style="list-style-type: none"> <li>Covers inside of stomach</li> <li>Protects stomach wall</li> </ul>
Parietal (Oxyntic) cell	HCl	<ul style="list-style-type: none"> <li>Maintains pH from 2-3</li> <li>Provide acidic medium for enzyme</li> <li>Softens food &amp; kills microorganisms</li> <li>Converts inactive pepsinogen into pepsin</li> </ul>
Zymogen (Chief) cell	Pepsinogen	It hydrolyzes proteins into peptones and polypeptides.

- End result of digestion in stomach is formation of semi-fluid mass called *chyme*.

DIGESTION IN SMALL INTESTINE

- There are three parts of small intestine i.e. duodenum, jejunum and ileum.
- Duodenum is first part of small intestine and is about 20-25 cm long.
- Pancreatic juice is produced by exocrine part of pancreas, which is poured in duodenum by pancreatic duct.

## Components of Pancreatic Juice

COMPONENT	ROLE	ACTION
Amylase (amylpsin)	Carbohydrate digesting enzyme	Starch into maltose
Lipase	Fat digesting enzyme	Fats into fatty acids & glycerol
Trypsin	Protein digesting enzyme	Proteins into peptones and polypeptides.
Sodium bicarbonate	-	Neutralizes chyme, provides alkaline medium

## Bile

- Liver secretes *bile*, which is stored in gall bladder and then transported to duodenum by bile duct.
- Bile* is green, watery fluid containing no enzyme.
- Green colour of bile is due to bile pigments produced due to breakdown of hemoglobin.
- Bile emulsifies fats i.e. converts it into small globules.
- Accumulation of bile pigments in blood causes *jaundice*.
- Secretin* is hormone produced by action of acidic food on internal mucosa of duodenum. It inhibits production of gastric secretions and promotes production of secretions of liver and pancreas.





## JEJUNUM AND ILEUM

- Jejunum is about 2.4 meter long and constitutes about  $\frac{2}{5}$ <sup>th</sup> while ileum  $\frac{3}{5}$ <sup>th</sup> of small intestine.
- Jejunum and ileum are involved in complete digestion of food.

### Enzymes Of Intestinal Lining

ENZYME	SUBSTRATES	PRODUCTS
Amino peptidase	Polypeptides	Dipeptides
Erypsin	Dipeptides	Amino acids
Lipase	Fats	Fatty acids & glycerol
Maltase	Maltose	Glucose
Lactase	Lactose	Glucose & galactose

- Finger-like projections present on inner lining of small intestine are called *villi* and they give velvety appearance.
- Each villus has outer covering of epithelial cells, blood capillaries and lacteals.
- *Microvilli* are present on villi produced through crypts.

## LARGE INTESTINE

- Large intestine is last part of alimentary canal and divided into caecum, colon and rectum.
- Finger-like appendix arises from caecum. Inflammation of appendix called *appendicitis*.
- *Colon* is longest part of large intestine. It is further divided into ascending, transverse and descending colon.
- Large intestine is involved in absorption of water and salts. Less absorption leads to *diarrhoea* and then dehydration. Excessive absorption leads to *constipation*.
- *Defecation reflex* is involved in emptying of rectum from faeces. It is consciously inhibited in individuals other than infants.

## DISORDERES RELATED TO GIT

DISEASE	DEFINITION	CAUSES	SYMPTOMS & COMPLICATIONS	TREATMENT
Dyspepsia	Incomplete or imperfect digestion	Acidity in stomach, faulty function of stomach, insufficient quality or quantity of bile	Abdominal discomfort, flatulence, heartburn, nausea, vomiting	Synthetic enzymes (pepsin 7 UP)
Food poisoning/ botulism	Illness from indigestion of food contaminated with toxic substances/ severe form of food poisoning	Salmonella, Campylobacter entering through unpasteurized milk or improperly cooked meat/ <i>Colostridium botulinum</i>	Abdominal pain, nausea, vomiting, abdominal pain, diarrhoea/ selective action on CNS causing fatigue, dizziness, double vision, headache, nausea, vomiting, abdominal pain	Hygienic conditions



Obesity	Abnormal amount of fats on body	Overeating, eating fatty food, hormonal	High blood pressure, heart disease, diabetes mellitus, stomach disorder	Reducing fatty food, eating balanced diet, hormonal therapy
Anorexia Nervosa	Loss of appetite due to fear of becoming obese	Psychological with onset of puberty and sexuality	Weight loss, metabolic disturbances	Psychiatric therapy, feeding through other route
Bulimia Nervosa	Neurotic disorder characterized by bouts of overeating fattening food.	Neurotic disorder	Self-induced vomiting, fasting, use of purgatives, purging, serum electrolyte imbalance, recurring infection.	To overcome effects of weight loss and malnutrition.
Piles (Hemorrhoids)	Masses of dilated, tortuous veins in anorectal mucosa	Unhygienic conditions	Bleeding, constipation, depressed urge to defecate, distention of rectum	Improvement of hygiene, roughage in food, laxatives, not to sit on hard seats, surgical
Pyrosis (heart burn)	Painful burning sensation in chest associated with back flush of acidic chyme into the oesophagus.	Overeating, eating fatty food, lying down immediately after meal, alcohol, caffeine, smoking	Burning sensation in chest	Decrease in acidity, decreased use of spicy food
Ulcer	Sore produced by eating away of walls of stomach or duodenum by digestive enzymes	Excess gastric acid secretion	Development of hole. Spilling into abdominal cavity, infection	Smoking, spicy food, alcoholic beverages, coffee, tea and stress avoidance



1. There are \_\_\_\_\_ pairs of salivary glands in humans.
2. End result of digestion in mouth is small oval lump called \_\_\_\_\_.
3. \_\_\_\_\_ are peristaltic contractions caused by low blood glucose level.
4. In gastric juice, HCl maintains pH from \_\_\_\_\_ to \_\_\_\_\_.
5. Duodenum is first part of small intestine and is about \_\_\_\_\_ long.
6. \_\_\_\_\_ is green, watery fluid containing no enzyme.
7. Finger-like projections present on inner lining of small intestine are called \_\_\_\_\_.
8. \_\_\_\_\_ reflex is involved in emptying of rectum from feces.
9. Incomplete or imperfect digestion of food is called \_\_\_\_\_.
10. \_\_\_\_\_ are masses of dilated, tortuous veins in anorectal mucosa.

Answers: (1) 3 (2) Bolus (3) Hunger Pangs (4) 2 to 3 (5) 20-25 cm (6) Bile (7) Villi (8) Defecation (9) Dyspepsia (10) Piles





## VALUES

Property	Value
pH of acidic medium of food vacuole in amoeba	5.6
pH of alkaline medium of food vacuole in amoeba	7.3
pH of fresh saliva	8
pH of saliva during digestion	6
pH of HCl (stomach)	2-3
Length of duodenum	20-25 cm
Length of jejunum	2.4 meter
Area occupied by jejunum of small intestine	2/5
Area occupied by ilium of small intestine	3/5
Hunger pangs start after	12-24 hours after previous meal
Symptoms of food poisoning occur after	12-24 hours of eating food





## PRACTICE EXERCISE



1. Carbohydrates, fats & proteins are essential for:
  - (a) Metabolic processes of an organism
  - (b) Providing energy.
  - (c) Formation of structures
  - (d) All of these
2. Magnesium is present in which of the following?
  - (a) Cytochromes
  - (b) ATP
  - (c) Chlorophyll
  - (d) Haemoglobin
3. Deficiency of which of the following causes chlorosis?
  - (a) Nitrogen
  - (b) Magnesium
  - (c) Iron
  - (d) Both A and B
4. Deficiency of  $K^+$  causes:
  - (a) Stunted growth & strong chlorosis
  - (b) No electron transport chains
  - (c) Premature death of leaves.
  - (d) Stunted growth of roots.
5. *Puccinia* is a parasitic:
  - (a) Plant
  - (b) Fungus
  - (c) Animal
  - (d) Algae
6. Autotrophic organisms can exist in an exclusively \_\_\_\_\_ environment.
  - (a) Organic
  - (b) Inorganic
  - (c) Wet
  - (d) Terrestrial
7. Strong chlorosis is due to the deficiency of \_\_\_\_\_ in plants.
  - (a) Magnesium
  - (b) Nitrogen
  - (c) Potassium
  - (d) Phosphorus
8. Stunted growth of roots is due to the deficiency of \_\_\_\_\_ in plants
  - (a) Potassium
  - (b) Magnesium
  - (c) Phosphorus
  - (d) Iron.
9. *Puccinia* commonly destroys
  - (a) Corn
  - (b) Tomato
  - (c) Dodder
  - (d) Wheat
10. Nodules on roots of leguminous plants have \_\_\_\_\_ bacteria
  - (a) Anaerobic
  - (b) Nitrogen fixing
  - (c) Nitrifying
  - (d) Ammonifying
11. All of the insectivorous plants are true
  - (a) Heterotrophs
  - (b) Autotrophes
  - (c) Carnivores
  - (d) Saprotrophs
12. The leaf is bilobed with midrib between them. The plant is
  - (a) *Saracenia*
  - (b) *Dionaea*
  - (c) Pitcher plant
  - (d) None of these.
13. Of the following, which one has more variety of nutrition?
  - (a) Animals
  - (b) Bacteria
  - (c) Plants
  - (d) Fungi
14. Earthworm is an example of \_\_\_\_\_ feeder
  - (a) Detritus
  - (b) Fluid
  - (c) Macrophageus
  - (d) Filter





15. Of the following, which one is missing in herbivores?  
 (a) Premolars (b) Canines  
 (c) Incisors (d) Molars.
16. Certain types of whales are also \_\_\_\_\_ feeder.  
 (a) Fluid (b) Macrophagous  
 (c) Filter (d) None of these
17. Hydra is an example of \_\_\_\_\_ feeder  
 (a) Fluid (b) Macrophagous  
 (c) Fluid (d) All of these
18. Parasites capable of living independently of its host at times is called as \_\_\_\_\_ parasite.  
 (a) Obligate (b) Strict  
 (c) Facultative (d) Endoparasite
19. In planaria, numerous small branches which end blindly are called as  
 (a) Digestive tract (b) Intestinal caeca  
 (c) Hepatic caeca (d) Both B & C
20. Midgut in cockroach is a short narrow tube called  
 (a) Hepatic caeca (b) Gizzard  
 (c) Stomach (d) Rectum
21. The partly digested food is stored in \_\_\_\_\_ in cockroach.  
 (a) Gizzard (b) Crop  
 (c) Hepatic caeca (d) Rectum
22. Hunger contractions are \_\_\_\_\_ contractions  
 (a) Antiperistalsis (b) Peristalsis  
 (c) Voluntary (d) None of these
23. A painful burning sensation produced in the chest cavity usually associated with the back flush of acidic chyme into the esophagus is  
 (a) Pyrolysis (b) Pyrosis  
 (c) Peristalsis (d) Dyspepsia
24. Hepatic and Pancreatic secretions are also stimulated by a hormone produced by the intestinal mucosa. The hormone is  
 (a) Creatin (b) Gastrin  
 (c) Secretin (d) Pepsin
25. It is about 2.4 meter in length and comprising about two fifth of the small intestine  
 (a) Duodenum (b) Jejunum  
 (c) Ileum (d) Caecum
26. Anus is surrounded by \_\_\_\_\_ types of muscles  
 (a) 2 (b) 3  
 (c) 1 (d) 4
27. Incomplete or imperfect digestion is known as  
 (a) Obesity (b) Dyspepsia  
 (c) Anorexia nervosa (d) Bulimia nervosa
28. One of the commonest cause of food poisoning are the toxins produced by  
 (a) Azobacter (b) Nitrosomonas  
 (c) Campylobacter (d) Nitrobacter
29. The liquid that escapes during defrosting frozen meat contains \_\_\_\_\_ bacteria  
 (a) Campylobacter (b) Nitrobacter  
 (c) Azobacter (d) Salmonella



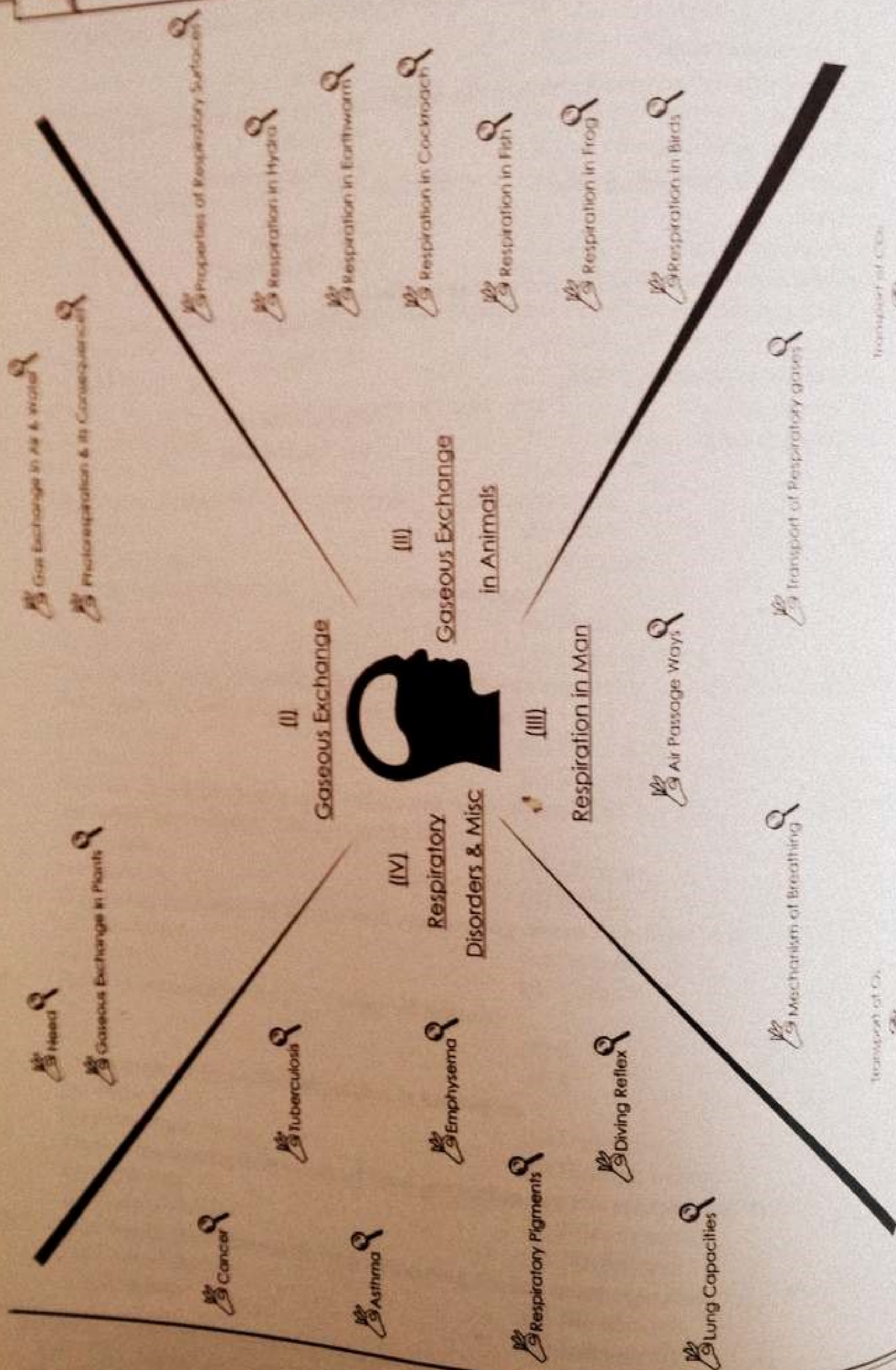


30. **Loss of appetite due to the fear of becoming obese is**  
(a) Anorexia nervosa (b) Bulimia nervosa  
(c) Piles (d) Dyspepsia
31. **An illness which largely affects girls usually just after the onset of puberty.**  
(a) Bulimia nervosa (b) Obesity  
(c) Anorexia nervosa (d) None of these
32. **Masses of dilated tortuous veins in the anorectal mucosa are known as**  
(a) Bulimia (b) Ulcer  
(c) Adipose tissue (d) Hemorrhoids.
33. **Mastication is carried out by:**  
(a) Teeth (b) Tongue  
(c) Smooth muscles (d) All of these
34. **Dipeptides into amino acids are converted through**  
(a) Amino peptidase (b) Erypsin  
(c) Pepsin (d) Trypsin
35. **Pepsinogen is produced from**  
(a) Mucous cells (b) Parietal cells  
(c) Zymogen cells (d) All of these



# Chapter 13

## GASEOUS EXCHANGE







### NEED FOR RESPIRATORY GASEOUS EXCHANGE

Respiration is an important metabolic activity which occurs at two levels:

- **Organismic level:** breathing or ventilation.
- **Cellular level:** Cellular respiration is the process by which cell utilizes oxygen, produces carbon dioxide, extracts and conserves the energy from food molecules in biologically useful form such as ATP.

### ADVANTAGES AND DISADVANTAGES OF GASEOUS EXCHANGE IN AIR AND IN WATER

**Breathing** is only by diffusion and active transport has no role.

#### Comparison between Air and Water

Air is better respiratory medium as compared to water due to following reasons.

FEATURE	WATER	AIR
Oxygen Contents	10ml O <sub>2</sub> / 1 litre	200 ml O <sub>2</sub> /1 litre
Rate of diffusion of O <sub>2</sub>	Less	More (8000 times than water)
Viscosity	More (50 times)	Less
Density	More (8000 times)	Less
Ventilation	Difficult	Easy

### GASEOUS EXCHANGE IN PLANTS

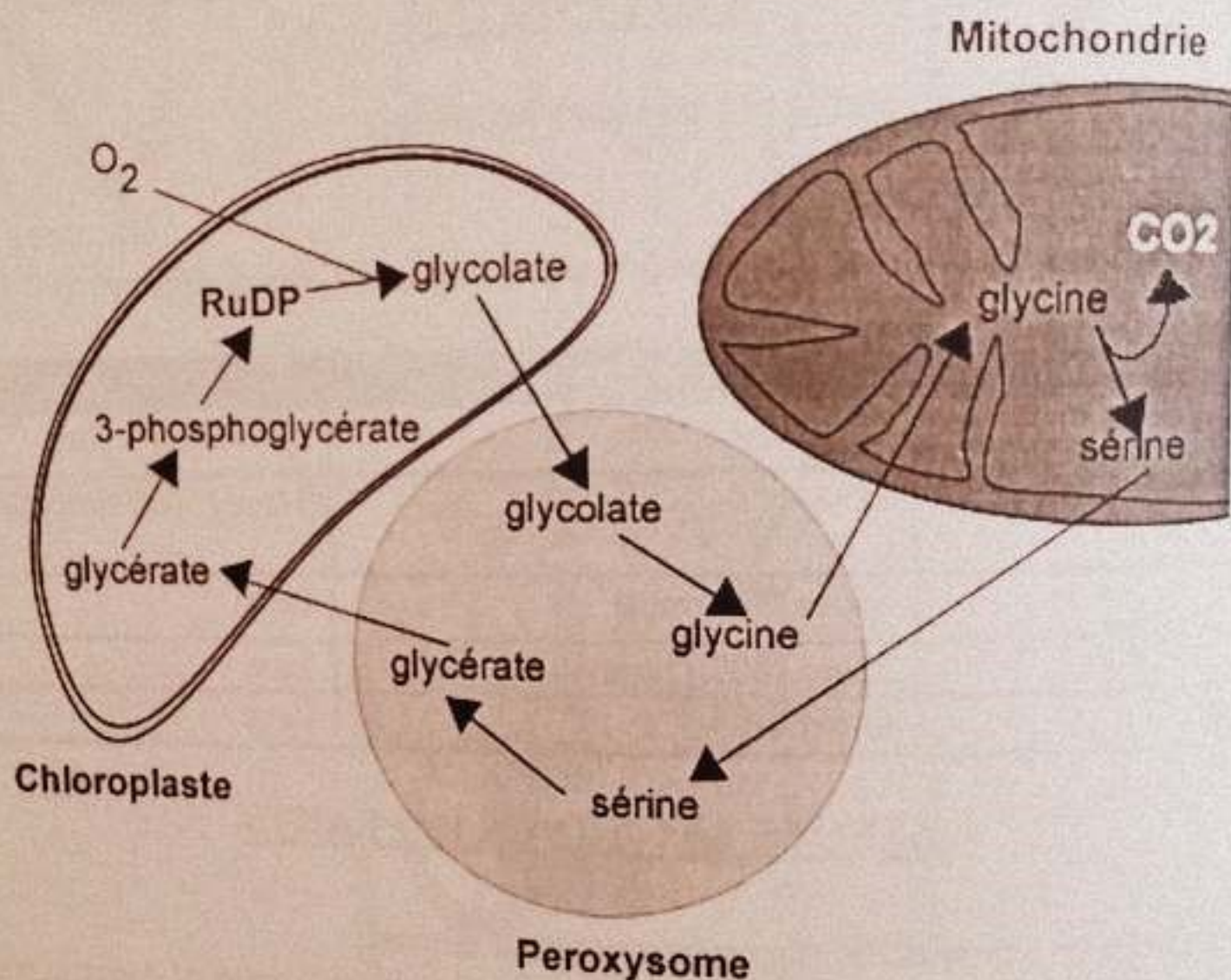
- Plants do not have any specific respiratory organ or system.
- Vascular tissues (xylem and phloem) are not involved in the transport of gases in plants.
- **Aquatic plants** obtain oxygen by diffusion from dissolved oxygen of water.
- **Stomata** are main source for gaseous exchange in land plants. They are mainly present on leaves and young stem.
- There are **12,000 stomata** per square centimeter of leaf surface in tobacco plant.
- In **young stem**, gaseous exchange is through stomata while in old stem is through lenticels.
- **Lenticels** are formed from dead cells of cork tissue.
- **Air spaces** comprise about 40% of total leaf volume.

### PHOTORESPIRATION

- Respiratory activity that occurs in plants during day time is called **photorespiration**.
- In photorespiration, **rubisco oxygenase** is involved.
- **Rubisco** is the most abundant protein in world out of which oxygenase comprises about 20%.
- $\text{RuBP} + \text{O}_2 \rightarrow \text{Glycolate (Chloroplast)} \rightarrow \text{Glycine (Peroxisomes)} \rightarrow \text{Serine} + \text{CO}_2$   
(Mitochondria)



Photorespiration	Calvin cycle
Oxygen is fixed	Carbon dioxide is fixed
Carbon dioxide is produced	Oxygen is produced
Oxygenase (rubisco) is involved	Carboxylase (rubisco) is involved
It retards growth	It promotes growth



### PROPERTIES OF RESPIRATORY SURFACES IN ANIMALS

- **Large surface area and moisture**, as seen in the form of lungs in vertebrates and gills in fish.
- **Thin epithelium**, which promotes diffusion.
- **Ventilation** maintaining a steep diffusion gradient.
- **Rich capillary network** to enhance the exposure of blood to respiratory gases.

### RESPIRATION IN HYDRA

- Hydra has **no specialized respiratory organ**.
- Gaseous exchange in hydra occurs through diffusion between body surface and water.

### RESPIRATION IN EARTHWORM

- They also don't have any specialized respiratory organs.





- Skin of earthworm is kept moist by secretions of epidermal mucous glands and by coelomic fluid through dorsal pores.
- $O_2 \rightarrow$  Dissolved  $\rightarrow$  Skin  $\rightarrow$  Combines with Hb  $\rightarrow$  Oxyhemoglobin  $\rightarrow$  Supplied to cells

### RESPIRATION IN COCKROACH

- Cockroach has *tracheal system* for respiration.
- Main tracheal trunk communicates with exterior by 10 pairs of apertures called *spiracles* present on lateral sides of body.
- 2 pairs of spiracles are present in thorax while 8 pair in each of first 8 abdominal segments.
- Trachea divides to form fine thin walled tubules called *tracheoles*.
- Tracheoles end in blind ducts partly filled with fluid called *end cells* which surround tissues and organs.
- Gaseous exchange occurs due to concentration gradient and *abdominal muscles* (dorsoventral muscles).
- *When abdomen expands*, the first 4 pairs of spiracles open, air rushes in through these spiracles.
- *When abdomen contracts*, the anterior 4 pairs of spiracles close and posterior 6 pairs open to expel air outside the body.

### RESPIRATION IN FISH

- Gaseous exchange in fish occurs through gills.
- *Gills* are paired structures present on either side of body almost at the junction of head and trunk.
- There are *four or five pairs* of gills which are either visible or placed in bronchial cavities covered with operculum.
- The blood enters from posterior side of the heart.

### RESPIRATION IN FROG

- There are three ways of respiration in frog i.e. cutaneous, buccal and pulmonary.
- **Cutaneous Respiration:** Respiration through skin is called *cutaneous respiration*.
- **Buccal respiration.** Respiration through buccal cavity is called *buccal respiration*.
- **Pulmonary Respiration:** Respiration through lungs is called *pulmonary respiration*.
- Air  $\rightarrow$  External nostrils  $\rightarrow$  Internal nostrils  $\rightarrow$  Buccal cavity  $\rightarrow$  Pharynx  $\rightarrow$  Trachea  $\rightarrow$  Lungs

### RESPIRATION IN BIRDS

- Respiratory system is most effective and elaborated.
- Tiny thin wall ducts, which at both the ends and the air is constantly ventilated in them are *parabronchi*.
- Lungs of birds are *balloon-like* present in chest cavity.
- *Air sacs* are extensions of lungs into all parts of the body including bones in birds.
- In most birds, air sacs are *nine* in number.
- In birds, there is one way flow of air through the lungs and the air is renewed after inspiration.



RESPIRATION IN MAN

- There are *two phases* of respiration through lungs i.e. inhalation and exhalation.
- Intake of air is called *inspiration* or inhalation.
- Removal of consumed air out of lungs is called exhalation or *expiration*.
- In man, respiratory system consists of two main components i.e. air passage way and lungs.
- Passage by which air passes in and out of lungs is called *air passage way*.
- Various components of air passage way are:

AIR PASSAGE WAY OF MAN

COMPONENT	STRUCTURE	FUNCTION
Nostrils and nasal cavities (two in number)	Each subdivided into three passage ways by projection of bones from wall of internal nose, hair, mucous secreting cells	Filtration, moistening and warming
Pharynx or throat	Muscular passage lined with mucous membrane	Channelizes air to larynx
Larynx (voice box)	Cartilaginous structure, upper end of trachea	Takes air from pharynx
	Glottis (opening of larynx), lined by mucous membrane	Vocal organ
	Epiglottis: cartilaginous, covering of glottis, muscularly controlled hinge like	Covers glottis during swallowing
	Vocal cords: stretched mucous membrane in form of fibrous bands	Voice production by vibration through air
Trachea: Tubular, ventral to oesophagus, windpipe	C-shaped cartilage rings, inner lining of ciliated and mucous cells	Cartilage rings prevent collapse of trachea, ultimate cleaning of air
Bronchi (2 in number)	Irregularly distributed cartilage plates	Transfer of air
Bronchioles	Diameter of 1 mm or less, no cartilage, only smooth muscles	Transfer of air
Air sacs	Several microscopic single layered structure called alveoli	Functional unit of lungs
Alveoli	Single layered surrounded by blood capillaries	Gaseous exchange

**Lungs**

- They are closed sacs that are connected to the outside by trachea and nostrils or mouth.

- Lungs themselves
- Lungs are
- Floor of
- Diaphragm contracts
- Walls of
- When in
- Ribs settle

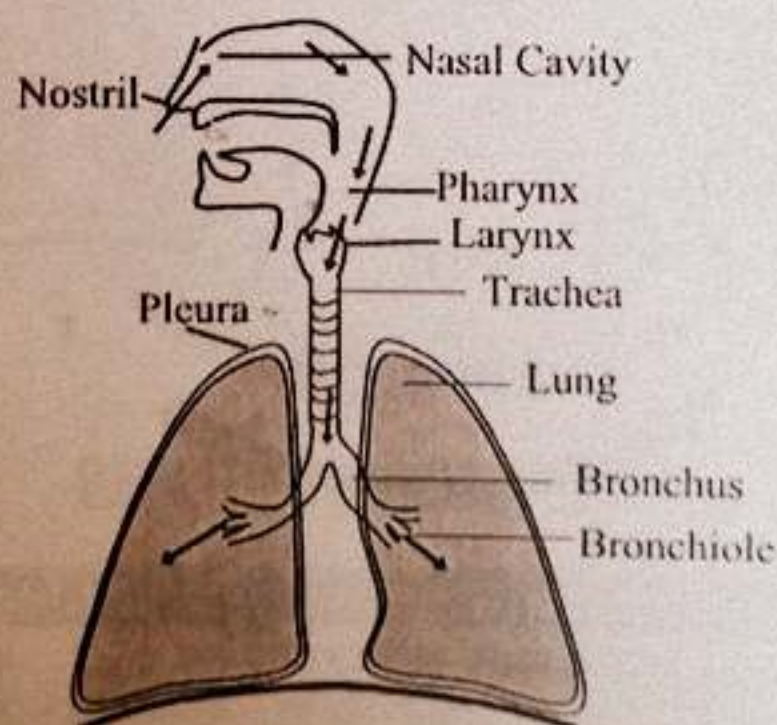
(5) Tracheal





1. Breathing is only by diffusion and \_\_\_\_\_ has no role.
2. Water is \_\_\_\_\_ times more denser than air.
3. Air spaces comprise about \_\_\_\_\_ of total leaf volume.
4. Respiratory activity that occurs in plants during day time is called \_\_\_\_\_.
5. Cockroach has \_\_\_\_\_ system for respiration.
6. \_\_\_\_\_ are extensions of lungs into all parts of the body including bones in birds.

- **Lungs** are spongy structure and cant neither pull the air inside nor expel it out by themselves.
- Lungs are covered by a double layered membranous sacs called **pleura**.
- Floor of cavity is called **diaphragm**. It is a sheet of skeletal muscles.
- **Diaphragm** is a dome like muscular structure, when relaxed and is flattened when contracted.
- **Walls** of chest cavity are composed of ribs and intercostal muscles.
- When **intercostal muscles** contract ribs are elevated.
- **Ribs** settle down when intercostals muscle relaxes.



Answers: (1) Active Transport (2) 8000 (3) 40% (4) Photorespiration (5) Tracheal (6) Air Sacs





# Chapter 13

## BREATHING IN MAN

## Gaseous Exchange

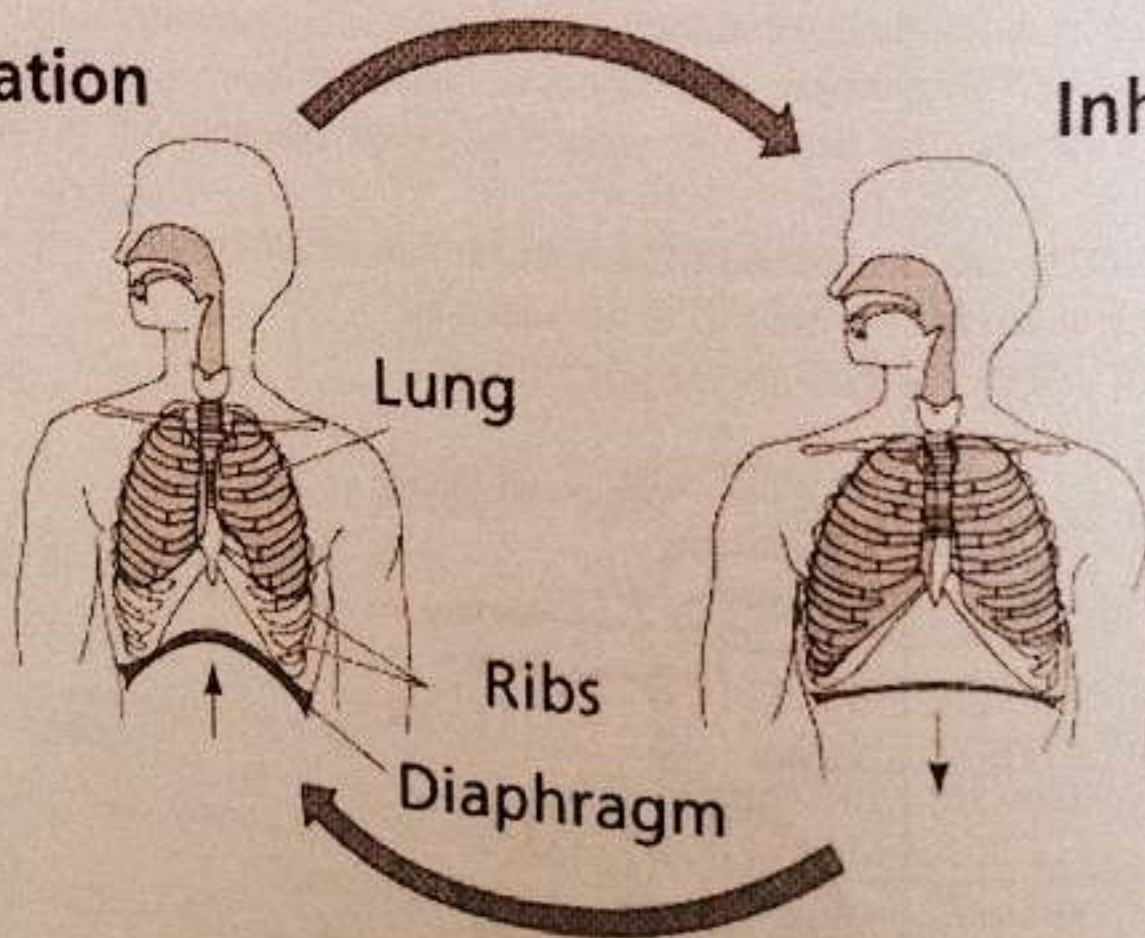
- Breathing is a mechanical process by which fresh air containing oxygen is pumped into the lungs and air with more carbon dioxide is pumped out of lungs.
- Normal breathing rate is 15-20 breaths/min and it can increase to 30/min during exercise.

### PHASES OF BREATHING

FEATURE	INSPIRATION	EXPIRATION
Other name	Inhalation	Exhalation
Basic Mechanism	Passive expansion of lungs	Passive contraction of lungs
Definition	Taking in of air	Removal of air from lungs outside body
Diaphragm	Contracts, moves down, becomes less dome-like	Relaxes, moves up, become more dome-like
Rib muscles	Contract	Relax
Rib cage	Moves upward and forward	Moves downward and inward
Volume of thorax	Increases	Decreases
Pressure on lungs	Decreases	Increases
Air moves	Into lungs	Out of lungs

### Exhalation

### Inhalation



### TRANSPORT OF RESPIRATORY GASES

#### Transport of Oxygen

- Most of the oxygen is transported through haemoglobin while some through plasma in dissolved form.
- Maximum capacity of haemoglobin to carry oxygen is about 20ml/100 ml of blood at sea level.



- At 100 m
- Oxyhae

#### Factors Affected

- Increase in
- Increase in
- Increase in

#### Transport of

- Carbon di
- 20% is
- (carbamin
- 5% by pla
- 70% as bic
- Small amo
- Arterial bl
- Venous bl
- Each 100m
- 4ml of bloo

CO<sub>2</sub> in plasma

O<sub>2</sub> in plasma

#### DISEASE

Respiratory distress syndrome

Cancer





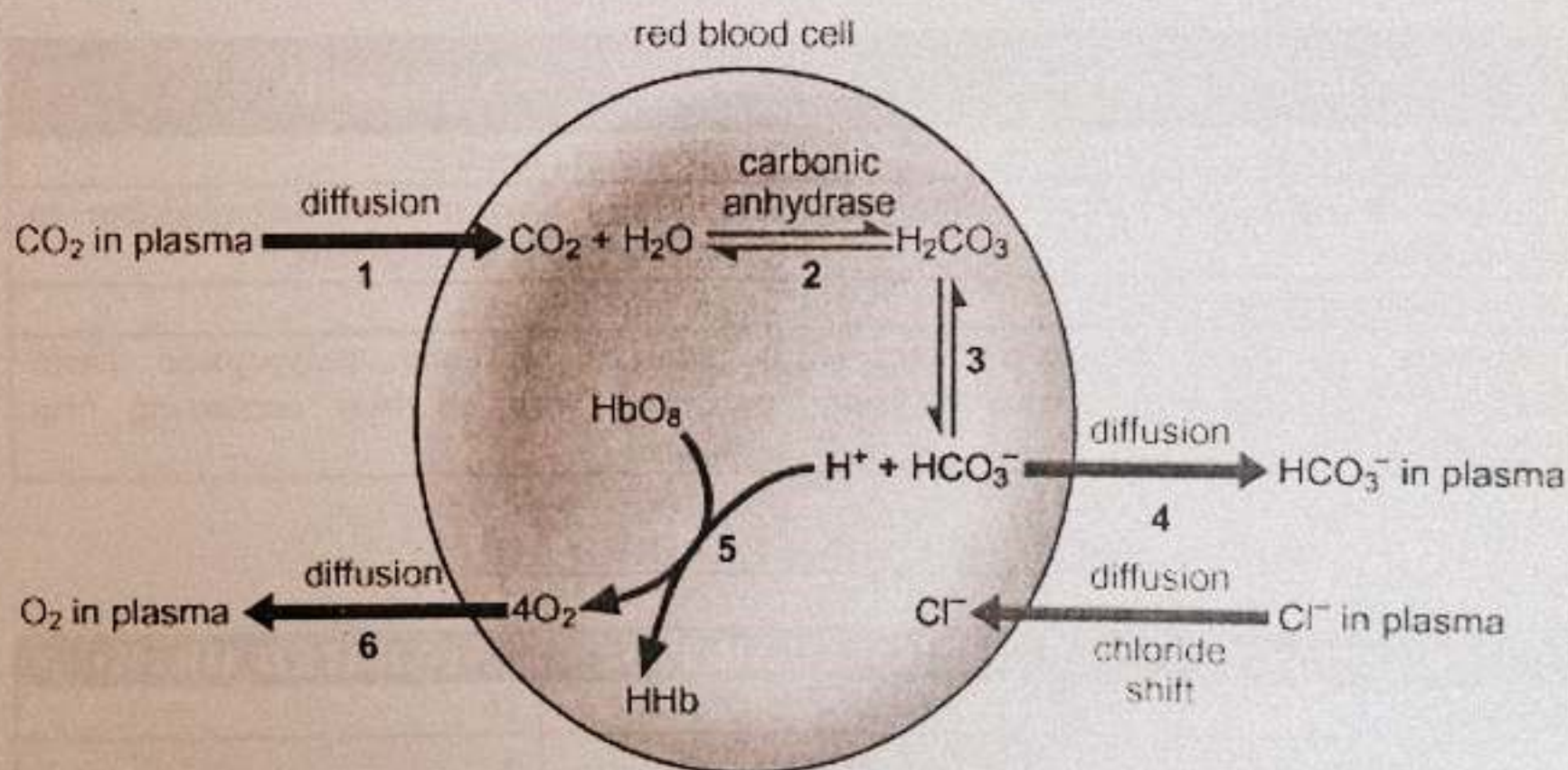
- At 100 mmHg oxygen tension, there is 19.6ml/100ml of blood, where it is 98% saturated.
- *Oxyhaemoglobin* is unstable at pressure below 60 mmHg.

#### Factors Affecting O<sub>2</sub> Holding Capacity of Hb

- Increase in temperature decreases capacity.
- Increase in concentration of CO<sub>2</sub> decreases.
- Increase in pH increases capacity.

#### Transport Of CO<sub>2</sub>

- Carbon dioxide is more soluble than oxygen.
- 20% is transported by combining with amino group of haemoglobin (*carbaminohaemoglobin*).
- 5% by *plasma proteins*
- 70% as *bicarbonate ions* combined with sodium in plasma.
- Small amount by corpuscles combined with potassium.
- *Arterial blood* contains about 50ml of CO<sub>2</sub>/100ml of blood.
- *Venous blood* contains 54ml of CO<sub>2</sub>/100ml of blood.
- Each 100ml of blood takes 4ml of carbon dioxide as it passes through the tissues and gives 4ml of blood as it passes through lungs.



#### RESPIRATORY DISORDERS

DISEASE	FEATURE	CAUSE	SYMPTOM
Respiratory distress syndrome	Syndrome of premature infants with gestation period less than 7 months	Decreased surfactant production	No gaseous exchange
Cancer	Malignant tumor of lung cancer	Smoking	





# Chapter 13

## Gaseous Exchange

<b>Tuberculosis</b>	Pulmonary tuberculosis, contagious easily spread (can)	Mycobacterium tuberculosis, poor people, malnutrition, poor living conditions	Cough, fever
<b>Asthma</b>	Allergic reaction of respiratory tract.	Pollen, spores, humidity, pollution	Sever paroxysm of difficult breathing followed by a period of complete relief with recurrent attacks
<b>Emphysema</b>	Breakdown of alveoli	Smoke	Smoker's cough, decrease in absorptive area, breathlessness, increased airway resistance

### RESPIRATORY PIGMENTS

- Two respiratory pigments are important in humans i.e. haemoglobin and myoglobin.
- **Hemoglobin** increases oxygen carrying capacity of blood to about 75 times.
- **Myoglobin** is also called muscle hemoglobin.

### COMPARISON OF HEMOGLOBIN AND MYOGLOBIN

HEMOGLOBIN	MYOGLOBIN
It is found in blood.	It is found in muscles.
It transfers oxygen from lungs to blood and then to tissues.	It transfers oxygen from haemoglobin to aerobic respiring muscle cells.
It cannot store oxygen.	It can store oxygen.
It consists of four polypeptide chains associated with an iron containing ring structure.	It consists of one polypeptide chain associated with an iron containing ring structure.

### INSPIRED AIR & EXPIRED AIR

COMPONENT	INHALED AIR (%)	EXHALED AIR (%)
Oxygen	21	16
Carbon dioxide	0.04	4
Water vapours	Variable	Saturated
Nitrogen	79	79

### DIVING REFLEX

- Shown by cetaceans.
- Diving mammals have almost twice the volume of blood in relation to their body weight.
- They have high concentration of myoglobin in their muscles.
- Following events occur during diving reflex:
  - Breathing stops.
  - Heart beat slows down to one tenth of the normal rate.





## Chapter 13

## Gaseous Exchange

- Consumption of oxygen and energy is reduced.
- The blood is redistributed but most of the blood goes to the brain and heart.
- Muscles shift from aerobic to anaerobic respiration.



1. Passage by which air passes in and out of lungs is called \_\_\_\_\_.
2. Walls of chest cavity are composed of ribs and \_\_\_\_\_ muscles.
3. Normal breathing rate is \_\_\_\_\_ breaths/min.
4. Most of the oxygen is transported through \_\_\_\_\_.
5. Oxyhemoglobin is unstable at pressure below \_\_\_\_\_ mmHg.
6. Arterial blood contains about \_\_\_\_\_ of  $\text{CO}_2$ /100ml of blood.

Answers: (1) Air Passage Way (2) Intercostal (3) 15-20 (4) Hb (5) 60 (6) 50 ml





## VALUES

Property	Value
Amount of oxygen in 1 litre water	Less than 10 ml
Amount of oxygen in 1 litre of air	200 ml
Diffusion of oxygen in air is more than water by	8000 times
Water is denser than air by	8000 times
Viscosity of water is more than air by	50 times
Number of stomata per square centimeter of leaf surface in tobacco leaf	12000
Volume of air spaces in leaf	40%
Reduction in carbon fixation into carbohydrate due to photorespiration	25%
Number of spiracles in cockroach	10 pairs
Rate of breathing at rest	15-20 times/ min
Gestation age for respiratory distress syndrome	Less than 7 month
Maximum capacity of blood to carry oxygen	20 ml/ 100 ml
Capacity of blood to carry oxygen at 100 mmHg	19.6 ml/ 100 ml
Transport of CO <sub>2</sub> as carboxyhemoglobin	20%
Transport of CO <sub>2</sub> by other plasma proteins	5%
Transport of CO <sub>2</sub> as bicarbonate ions	70%
Amount of CO <sub>2</sub> in arterial blood	50 ml/ 100 ml
Amount of CO <sub>2</sub> in venous blood	54 ml/ 100 ml
Amount of CO <sub>2</sub> transported by blood	4 ml/ 100 ml
Lung cancer caused by smoking	90%
Maximum rate of breathing	30 times/ min





## PRACTICE EXERCISE



1. \_\_\_\_\_ respiration is directly involved in the production of energy, necessary for all living activities.  
 (a) Organismic (b) Cellular  
 (c) Both of these (d) None of these
2. \_\_\_\_\_ respiration is the process by which cell utilizes oxygen and produces  $\text{CO}_2$ .  
 (a) Cellular (b) Organismic  
 (c) Both of these (d) None of these
3. Of the following, which one is better respiratory medium.  
 (a) Air (b) Water  
 (c) Soil (d) None of these
4. Oxygen contents per liter of air is  
 (a) 10 ml (b) 100 ml  
 (c) 200 ml (d) 100ml
5. Water is \_\_\_\_\_ times viscous than air  
 (a) 50 (b) 1000  
 (c) 5000 (d) 8000
6. There are \_\_\_\_\_ stomata per square cm of leaf surface in Tobacco plants.  
 (a) 1200 (b) 12000  
 (c) 100,000 (d) 1000
7. The air spaces may comprise upto \_\_\_\_\_ of total volume of leaf surface.  
 (a) 30% (b) 20%  
 (c) 40% (d) 50%
8. The glycolate produced diffuses into the membrane bounded organelles called  
 (a) Glyoxisomes (b) Peroxisomes  
 (c) Lysosomes (d) Mitochondria
9. Active site of Rubisco is evolved to bind  
 (a)  $\text{CO}_2$  (b)  $\text{O}_2$   
 (c) Both of these (d)  $\text{H}_2\text{O}$
10. Number of spiracles present in cockroach is  
 (a) 15 (b) 10  
 (c) 20 (d) 30
11. Number of spiracles present in the thorax of cockroach is  
 (a) 2 (b) 3  
 (c) 5 (d) 4
12. When abdomen expands, the number of spiracles open is  
 (a) 2 (b) 3  
 (c) 6 (d) 8
13. The blood enters the \_\_\_\_\_ side of heart  
 (a) Posterior (b) Anterior  
 (c) Lateral (d) All possible
14. Gaseous exchange through the skin is known as \_\_\_\_\_ respiration.  
 (a) Cuticular (b) Cutaneous  
 (c) Skin (d) Pulmonary





15. Parabronchi are open at \_\_\_\_\_ end/s  
 (a) Single (b) Both  
 (c) Do not have opening (d) None of these
16. In most birds air sacs are \_\_\_\_\_ in number  
 (a) 10 (b) 3  
 (c) 4 (d) 9
17. Vocal cords are stretched across  
 (a) Larynx (b) Pharynx  
 (c) Glottis (d) None of these
18. Functional units of lungs are called  
 (a) Alveoli (b) Air sacs  
 (c) Parabronchi (d) None of these
19. Lungs are spongy due to the presence of million of  
 (a) Air sacs (b) Alveoli  
 (c) Bronchioles (d) Parabronchi
20. Lungs are covered with double layered thin membranous sac called  
 (a) Diaphragm (b) Pleura  
 (c) Pericardium (d) Rib cage
21. During rest the breathing occurs rhythmically at the frequency of \_\_\_\_\_ times per minute in human  
 (a) 16-30 (b) 15-20  
 (c) 5-10 (d) 6-12
22. The maximum amount of oxygen which normal human blood absorbs and carries at sea level is \_\_\_\_\_ per 100 ml of blood.  
 (a) 10 ml (b) 20 ml  
 (c) 30 ml (d) 40 ml
23. Haemoglobin can be almost completely oxygenated by an oxygen pressure of \_\_\_\_\_ of mercury.  
 (a) 10 mm (b) 60 mm  
 (c) 100 cm (d) 100mm
24. Important factors which affect the capacity of haemoglobin to combine with oxygen is  
 (a) Temperature (b) Carbon dioxide  
 (c) pH (d) All of these
25. The increase in pH of blood has \_\_\_\_\_ effect on the oxygen carrying capacity of haemoglobin  
 (a) + ve (b) - ve  
 (c) No (d) All of these.
26. % age of CO<sub>2</sub> carried as carboxyhaemoglobin is  
 (a) 5% (b) 70%  
 (c) 20% (d) 10%
27. Arterial blood contains \_\_\_\_\_ of CO<sub>2</sub> per 100 ml of blood  
 (a) 54 ml (b) 60 ml  
 (c) 64 ml (d) 50 ml
28. More than \_\_\_\_\_ compounds of tar of tobacco smoke are involved to cause cancer  
 (a) 5 (b) 90  
 (c) 15 (d) 10



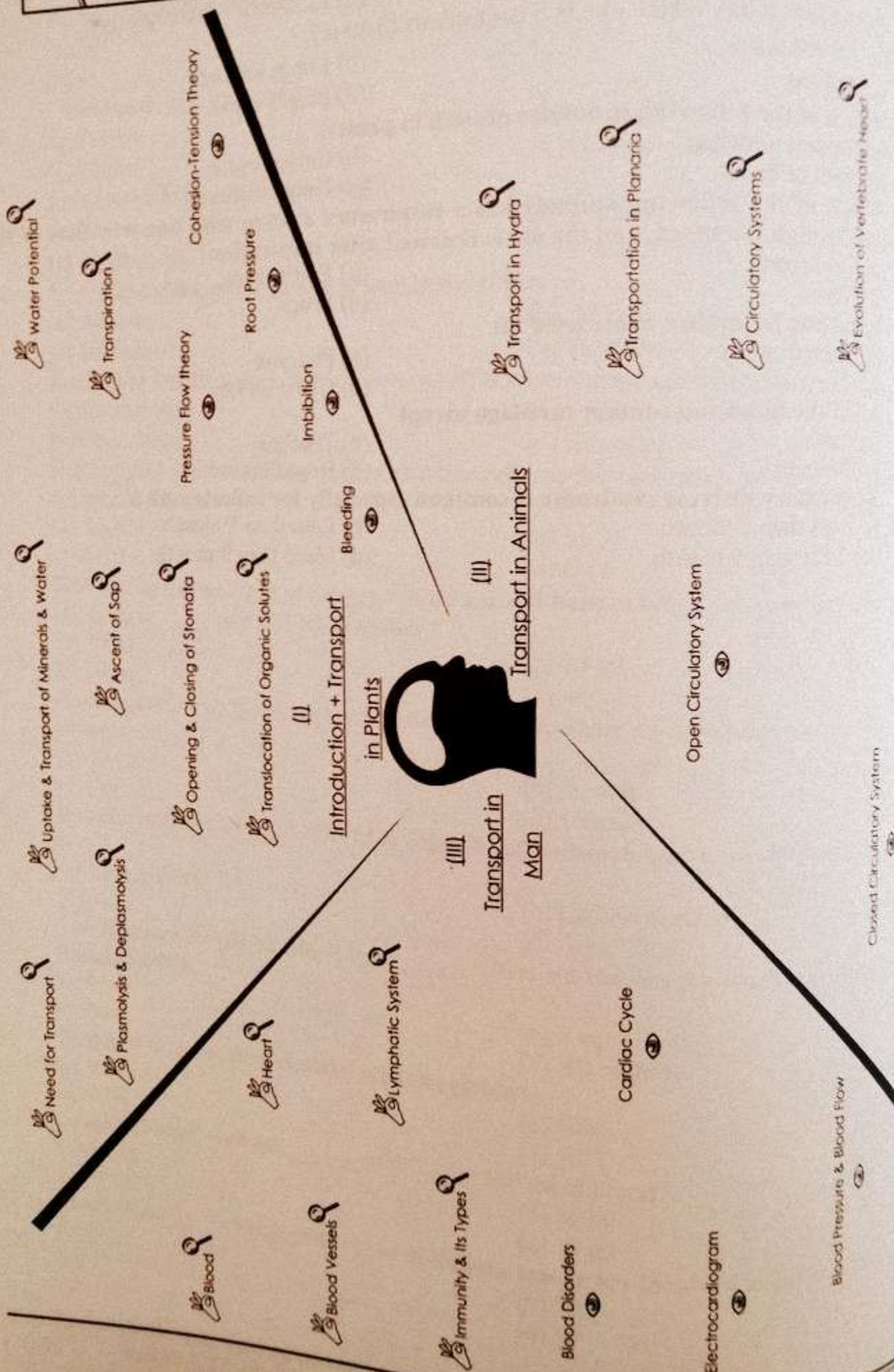


29. A disease of lungs in which inside of the lungs is damaged resulting in cough and fever  
(a) Lung cancer (b) Asthma  
(c) Emphysema (d) Pulmonary tuberculosis
30. Of the following, which one is a contagious disease?  
(a) Tuberculosis (b) Lungs cancer  
(c) Asthma (d) Emphysema
31. Which of the following promotes growth in plants?  
(a) Photorespiration (b) Calvin cycle  
(c) Both of these (d) None of these
32. Which of the following animals has a respiratory system with one way flow of the air through the lungs, and the air is renewed after inspiration?  
(a) Cockroach (b) Earthworm  
(c) Aves (d) Frogs
33. Voice box is another name used for  
(a) Buccal cavity (b) Pharynx  
(c) Larynx (d) Chest Cavity
34. All of the following contain cartilage except  
(a) Larynx (b) Trachea  
(c) Bronchi (d) Bronchioles
35. Respiratory distress syndrome is common especially for infants with a  
(a) Less than 7 month (b) Less than 8 month  
(c) Less than 9 month (d) More than 9 month



# Chapter 14

## TRANSPORT



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- Symplast P**
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  - Cytopla...
  - plasmoo...



INTRODUCTION

- The process involved for getting the material into and out of the cells are diffusion, facilitated diffusion, osmosis active transport, endocytosis, exocytosis etc.
- There is no mass flow systems in unicellular and lower multicellular organisms.

TRANSPORT IN PLANTS

- There are three types of nutrients needed by plants, carbon dioxide, water and minerals besides light to carry out photosynthesis.
- **Root hairs** are dense cluster of tiny hair like structure which are extensions of epidermal cells of roots.
- 67 % of the total surface area of the roots is provided by the root hair.
- These are the sites where most of the uptake of water and minerals take place.
- When the soil minerals are not in the solution form rather bound by ionic bond to soil particles, they are not available to plants.
- The rate of absorption of individual mineral which is independent of rate of absorption of water molecules is determined by:
  - Concentration both inside and outside of the root cells.
  - The ease with which it can passively penetrate cell membrane.
  - Extent to which carrier molecules and active absorption is involved.

**Processes Involved in Absorption by Roots**

- Minerals with higher concentration in root cells can also be taken in (against the concentration gradient)
- It utilizes energy in the form of ATP.
- Such type of diffusion that occurs through carrier proteins is called facilitated diffusion.

**Uptake of Water by Roots**

- Movement of water molecules from a region of higher water potential to a region of lower water potential through a partially permeable membrane is called *osmosis*.
- Movement of water molecules by osmosis into a cell is called endosmosis.
- Movement of water molecules by osmosis outside a cell is called exosmosis.
- Three **pathways** are commonly involved in transport of water and minerals i.e. apoplast, symplast and vacuolar pathway.

**Apoplast Pathway**

- This involves system of adjacent cell walls which is continuous throughout the plant roots.
- In the roots, apoplast pathway becomes discontinuous in the endodermis due to the presence of casparian strips.
- Apoplast pathway is of greatest importance for both water and solute transport.

**Symplast Pathway**

- Symplast pathway is the system of interconnected protoplasts in the root cells.
- Cytoplasm of neighboring cells (protoplast) are connected with one another by **plasmodesmata** (cytoplasmic strands that extend through pores in adjacent cell walls).

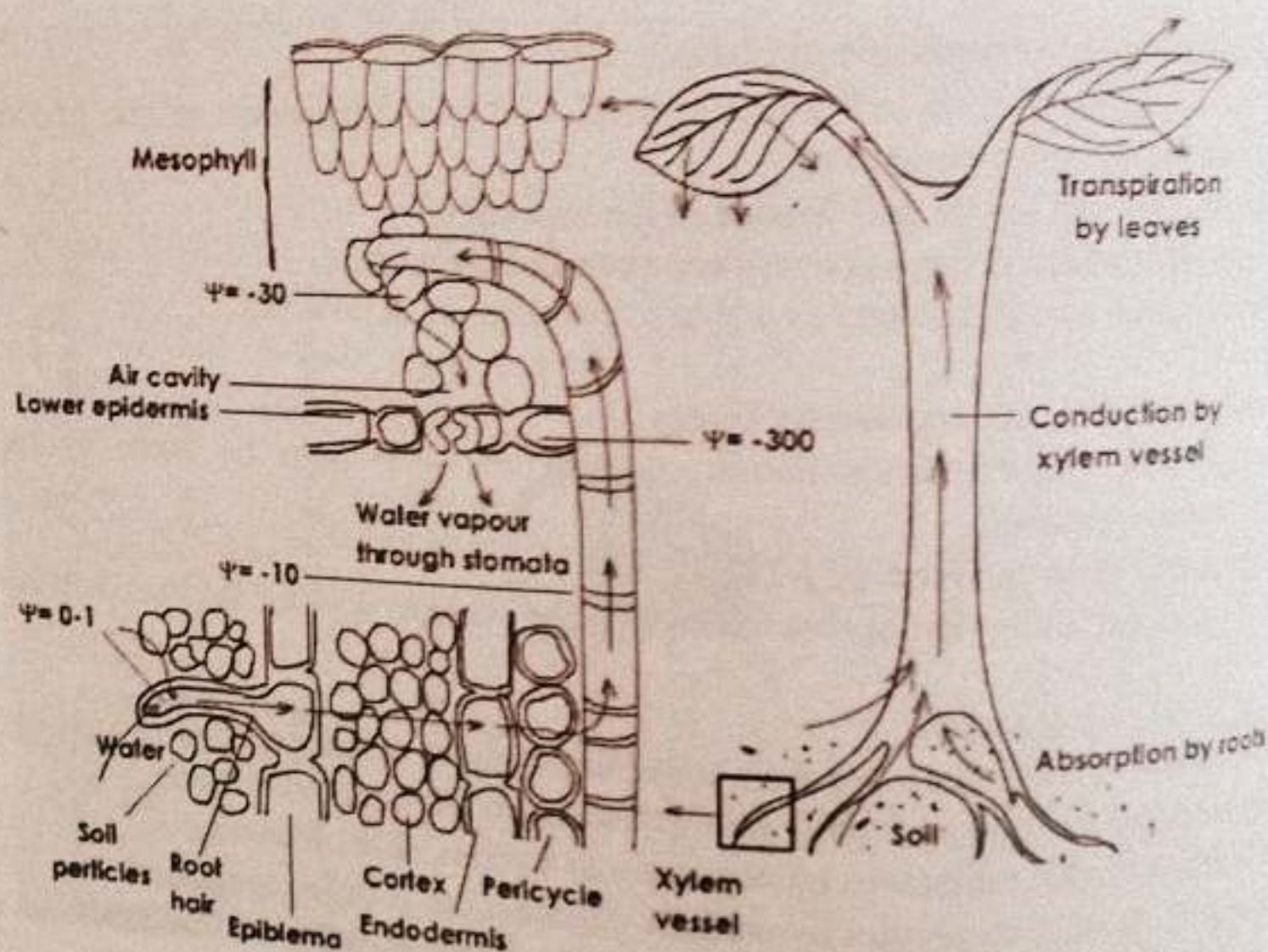


**Vacuolar Pathway**

Water move passively down the concentration gradient from vacuole to vacuole.

**WATER POTENTIAL**

- Greater the concentration of water molecules in a system the greater is the total kinetic energy of water molecules. This is called *water potential*.
- Pressure generated when water enters and inflates plant cells is called *pressure potential*.
- Pure water has maximum water potential which by definition is zero.
- Total water potential is sum of solute and pressure potential.
- When a cell is placed in a solution having lower water potential than that of the cell is called *plasmolysed*.
- The point at which plasmolysis is just about to happen is called *incipient point*.

**ASCENT OF SAP**

- Pulling upward of water and dissolved minerals towards the leaves through the xylem tissue is called ascent of sap.
- It is explained through cohesion tension theory, root pressure and imbibition.

**COHESION TENSION THEORY**

- It was proposed by Dixon.
- According to this theory uptake of water depends upon cohesion and tension.



- **Cohesion** is the attraction among water molecule (H-bond) forming a solid chain like column within the xylem tubes.
- **Tension** is present between the water molecules, when pulled up in the xylem tissue.
- **Adhesion** develops between water molecules and cell wall of xylem cells.

### ROOT PRESSURE

- A pressure created by active secretion of salts and other solutes from root cells into xylem sap, which lowers the water potential of the xylem sap is called root pressure.
- A pressure of 100 – 200 KPa (exceptionally 800 KPa) is generated by root pressure.
- **Guttation or exudation** is a loss of liquid water through water secreting glands or hydathodes.
- It is caused by root pressure in small plants like grasses.

### IMBIBITION

- It was first proposed by Sacks.
- Uptake of water e.g., by cell wall components like cellulose as a result they increase in volume, but the component does not dissolve in water is called imbibition.
- It is a reversible process.

### BLEEDING

- Flow of sap from cut ends or surfaces is called bleeding.
- It is mostly seen in land plants in spring.
- It is created by two factors i.e. hydrostatic pressure and root pressure.

### TRANSPIRATION

Evaporation of water from aerial parts of plant is called transpiration.

#### Types Of Transpiration

FEATURE	CUTICULAR	LENTICULAR	STOMATAL
<b>Component</b>	Cuticle	Lenticel	Stomata
<b>Structure</b>	Present on upper & lower epidermis, impermeable to water, water lost from thin areas.	Aerating pores formed from bark from cork, in stem of some plants, externally scars or protrusions	Guard cell, dumbbell shaped.
<b>%age</b>	5-7%	1-2%	90%

#### Factors Effecting Rate Of Transpiration

##### Light

The opening and closing of stomata is directly controlled by the light.

##### Temperature

- Rate of transpiration doubles at every rise of 10°C in temperature.
- Stomata close at very high temperature i.e., 40 -45° C.



**CO<sub>2</sub> Concentration**

Low concentration of carbon dioxide stimulates the stomata to open.

**Humidity And Vapour Pressure**

Transpiration increases with increase in dryness of the atmosphere.

**Wind**

Air in motion increases the rate of transpiration

**Availability of Soil Water**

If little water is available to be transported little will lose in the form of transpiration.



- \_\_\_\_\_ are dense cluster of tiny hair like structure which are extensions of epidermal cells of roots.
- Such type of diffusion that occurs through carrier proteins is called \_\_\_\_\_.
- \_\_\_\_\_ are cytoplasmic strands that extend through pores in adjacent cell walls.
- The point at which plasmolysis is just about to happen is called \_\_\_\_\_.
- Cohesion – Tension Theory was proposed by \_\_\_\_\_.
- Flow of sap from cut ends or surfaces is called \_\_\_\_\_.
- Stomata close at very high temperature i.e. \_\_\_\_\_ °C.

**OPENING AND CLOSING OF STOMATA**

- Guard cells** function as multisensory hydraulic valves
- There are two hypotheses which may explain opening and closing of stomata i.e. starch sugar hypothesis and influx of K<sup>+</sup>.

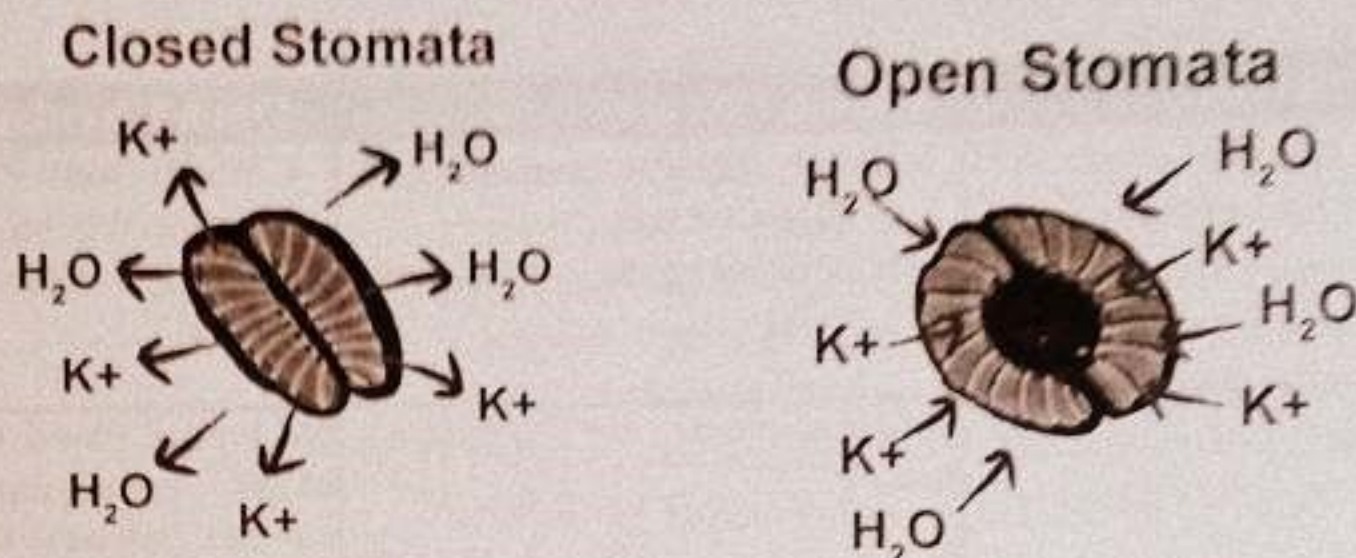
Feature	Starch-sugar hypothesis	K <sup>+</sup> ion influx hypothesis
<b>Opening of stomata</b>	During day due to presence of light, photosynthesis occurs in guard cells. In order to balance sugar level, water enters, caused turgidity and opening.	During day, active transport of K <sup>+</sup> occurs into guard cells following entry of water through osmosis. It causes turgidity and opening of stomata.
<b>Closing of stomata</b>	During night, no photosynthesis, use or conversion of glucose into insoluble starch. Water leaves guard cell causing flaccidity and closing of stomata.	Passive diffusion of K <sup>+</sup> outside the guard cells following exosmosis of water. It results in flaccidity and closing of stomata.

Answers: (1) Root Hair (2) Facilitated Diffusion (3) Plasmodesmata (4) Incipient Plasmolysis (5) Dixon (6) Bleeding (7) 40-45





- The German botanist *H-Van Mohl* proposed that the guard cells are the only photosynthesizing cells of epidermis of leaf.



### TRANSLOCATION OF ORGANIC SOLUTES

- The phloem constitutes the *inner bark*.
- The cells of phloem that conduct or transport sugars and organic material throughout the plant are called sieve elements.
- Transport or translocation occurs from the area of supply (sources) to area of metabolism or storage called sinks.
- In biennials e.g. root of beet is a sink in first growing season but becomes source in the next growing season, when sugars are utilized in growth of new shoots.
- The movement in phloem is from source to sink in most of the plant during active photosynthesis.

#### **Pressure Flow Theory**

- The theory called *pressure flow theory* is the most acceptable theory for the transport in the phloem of angiosperms.
- A hypothesis was first proposed by *Ernst Munch* in 1930. It states that the flow of solution in the sieve elements is driven by an osmotically generated pressure gradient between source and sink.
- The pathway taken by sucrose is symplast in most cases, but in some apoplast. Sucrose is actively transported to the sieve elements.
- In the storage sinks e.g. sugar beet, root and sugarcane stem, sucrose is removed into apoplast prior to entering symplast of the sink.

### TRANSPORT IN ANIMALS

- Unicellular and simple multicellular organisms have no special transport system, transportation of material is achieved by simple diffusion, facilitated diffusion, active transport and osmosis.
- Complex multicellular organisms have well organized transport system comprising of blood and vascular system.

#### **Circulatory System**

There are three components of circulatory system i.e.

- Circulating fluid i.e. blood.
- Modified blood vessel or heart



- Tubes or Blood vessels

### Open and Closed Circulatory System

Difference	Closed Circulatory System	Open Circulatory System
Definition	<ul style="list-style-type: none"> <li>• Blood always remains in blood vessels.</li> <li>• It does not make contact with cells.</li> </ul>	<ul style="list-style-type: none"> <li>• Blood does not remain enclosed in blood vessels.</li> <li>• It makes direct contact with cells.</li> </ul>
Blood vessels	Arteries, veins and capillaries present	No typical blood vessels. Blood called hemolymph flows in cavities (sinuses) of body cavity (haemocoel).
Exchange of nutrients and wastes	It occurs by capillaries between blood and cells via tissue fluid.	It occurs directly between blood and cells when blood directly bathes tissues.
Transport of gases	It also transports gases i.e. $O_2$ and $CO_2$ .	It does not transport gases. These are transported by tracheal system.
Respiratory pigment	Respiratory pigment i.e. hemoglobin is present in blood. Nucleated white blood cells are also present.	There is no respiratory pigment. Nucleated white blood cells are present.
Colour of blood	Red due to presence of hemoglobin.	Colourless due to absence of respiratory pigment.
Evolutionary relation	It is regarded as the most advanced type having <ul style="list-style-type: none"> <li>• Greater efficiency.</li> <li>• Maintenance of blood pressure.</li> <li>• Economy of blood volume.</li> </ul>	It is regarded as primitive type having <ul style="list-style-type: none"> <li>• Lesser efficiency.</li> <li>• No maintenance of blood pressure and blood volume.</li> </ul>
Example	Earthworm ( <i>Pheretima</i> )	Cockroach ( <i>Periplaneta</i> )

### Comparison Between Circulatory Systems of Earthworm and Cockroach

Difference	Earthworm	Cockroach
Hearts	There are 4 or 5 pairs of lateral hearts on lateral side of oesophagus in 7 <sup>th</sup> to 13 <sup>th</sup> segment. Hearts pump blood from dorsal to ventral vessel.	Heart is 13-chambered tubular blood vessel present in pericardial sinus and placed in mid dorsal region below terga in abdominal region. Each heart chamber has pair of lateral opening called ostia. Alary muscles on side of heart chambers help in flow of blood.
Blood vessels	Three main longitudinally	Portion of blood vessel in





	running blood vessels i.e. dorsal, ventral and subneural are interconnected by capillaries and commissural vessels.	thoracic and head region is called aorta. It opens in hemocoel of head by a funnel shaped opening.
<b>Mechanism of blood flow</b>	<ul style="list-style-type: none"> <li>• Dorsal vessel collects blood from 14<sup>th</sup> segment backward and in first 13<sup>th</sup> segments distributes to ventral vessel via hearts.</li> <li>• Ventral vessel is main distributing vessel with backward flow.</li> <li>• Subneural vessel is main collecting vessel with backward flow. It communicates with dorsal vessel via commissural vessels.</li> </ul>	The flow of blood is from heart to aorta and then to hemocoel. In hemocoel, it flows through perivisceral sinuses, perineural sinuses and pericardial sinuses and then back to heart.

### EVOLUTION OF VERTEBRATE HEART

- The **heart of fishes** have sinus venosus, an atrium, a ventricle and bulbous arteriosus or conus arteriosus. Sinus venosus receives deoxygenated blood from the body.
- The heart of fishes never receive oxygenated blood. Only the deoxygenated blood passes through different chambers of the heart.
- In **amphibians** the heart is three-chambered in regard to auricles and ventricles.
- In amphibians, sinus venous receives deoxygenated blood from the two-superior vena cava (precavals) and one inferior vena cava (postcaval).
- In amphibians there is complete mixing of oxygenated and deoxygenated blood in the ventricle.
- The **heart of reptiles** functions as four-chambered heart.
- There are two auricles in the heart of reptiles. In crocodile the inter-ventricular septum is complete and heart is four chambered.
- In all reptiles left and right systemic arches carry oxygenated blood and arise from a region of ventricle called **cavum venosum** into which left ventricle directs its blood.
- The deoxygenated blood from the right atrium is directed toward the entrance of the pulmonary trunk, which is also located or starts from a pocket the **cavum pulmonale** on right side of ventricle in the animals (reptiles) which do not have completely divided ventricles.
- The left systemic disappears in birds and right systemic most of it disappears in mammals.
- In reptiles, birds and mammals as a result of modifications, all blood returning to the right side of the heart passes to the lungs.
- The **systemic arch** distributes blood to different parts of the body and then the blood from the body returns to the heart in the right atrium via pre-caval and post caval. This is systemic circulation.





1. The phloem constitutes the \_\_\_\_\_ bark.
2. \_\_\_\_\_ type of blood circulatory system does not transport gases.
3. In Cockroach, \_\_\_\_\_ muscles on side of heart chambers help in flow of blood.
4. In amphibians the heart is \_\_\_\_\_ chambered.
5. The left systemic disappears in \_\_\_\_\_.
6. In biennials e.g. root of beet is a \_\_\_\_\_ in first growing season.

### TRANSPORT IN MAN

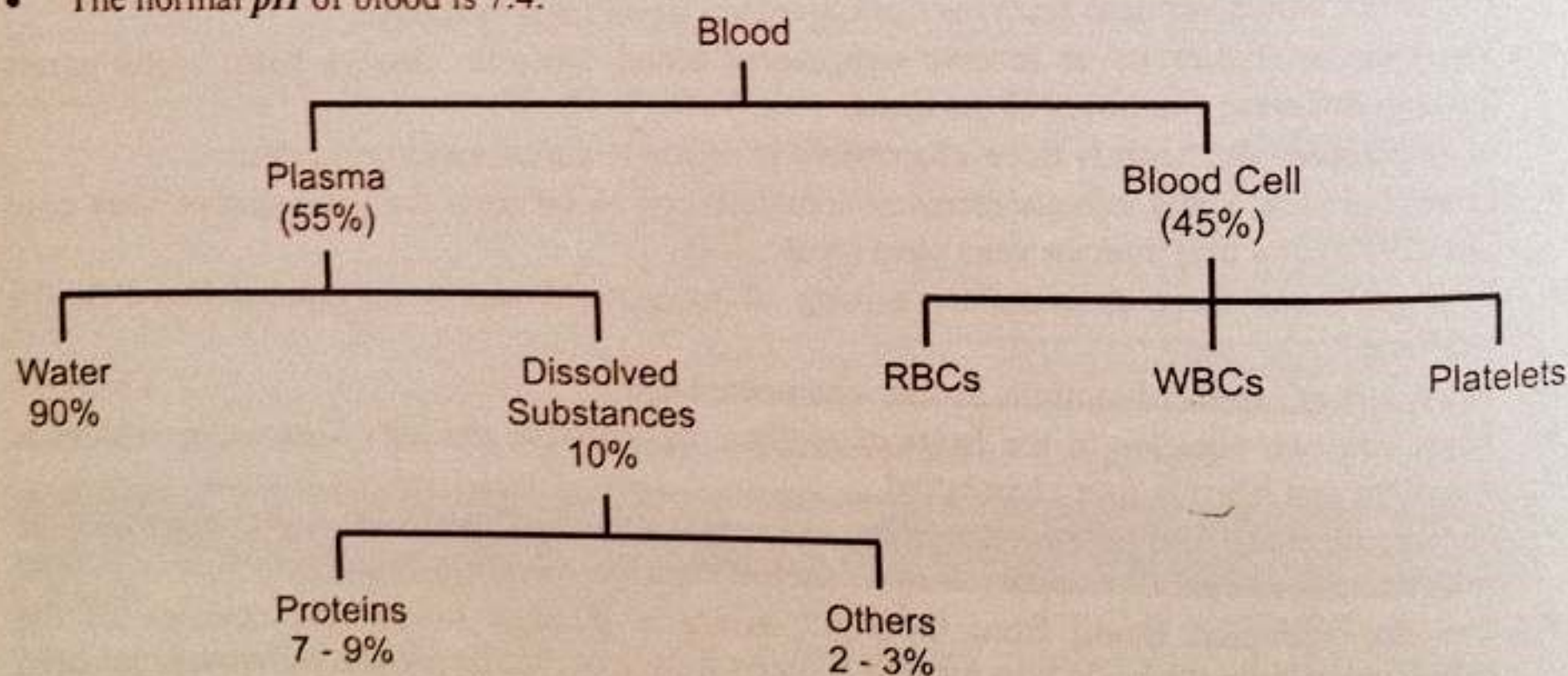
#### BLOOD CIRCULATORY SYSTEM

It has three components i.e.

- 1) Blood
- 2) Heart
- 3) Blood vessels

#### **Blood**

- The weight of blood in our body is about  $1/12^{\text{th}}$  of our body.
- The normal *pH* of blood is 7.4.



Answers: (1) Inner (2) Open (3) Alary (4) 3 (5) Birds (6) Sink



**PLASMA****Inorganic Ion Or Mineral Ions**

- They constitute 0.9 % of the plasma.
- More than 2/3 is NaCl.

**The Plasma Proteins**

- 7- 9 % by weight of the plasma.
- Most of these are synthesized in liver.
- Immunoglobulins or antibodies synthesized by lymphocytes are involved in defense system of body.
- *Prothrombin* acts as a catalyst in blood clotting process.
- Fibrinogen takes part in the blood clotting process.
- The plasma proteins maintain colloid osmotic pressure blood (75% by albumins, 25% by globulins and almost none by fibrinogen).

**Organic Nutrients In The Blood**

Include glucose, fats, phospholipids, amino acids and lactic acids and cholesterol.

**Nitrogenous Waste Products**

- Formed as a result of cellular metabolism.
- Carried from liver to kidneys, from where they are removed.

**Hormones**

Are also carried via blood to various parts of body.

**The Gases**

Like O<sub>2</sub> and CO<sub>2</sub>.

**BLOOD CELLS**

- A cubic millimeter contains 5-5.5 million of RBC in males and 4 – 4.5 million in females.
- *Erythrocytes*, when formed, have nucleus, but is lost before they enter the circulatory fluid or blood.
- 95% of the cytoplasm of RBC is red pigment called haemoglobin, the remaining 5% consists of enzymes, salts and other proteins.
- The *RBC* once mature do not divide. These cells are *biconcave* and have an *elastic cell membrane*.
- The *average life span of RBC* is about 4 months after which it breaks down and disintegrated in the liver and spleen partly by phagocytes.
- About *2-10 million RBC are formed* and destroyed every second in normal person.
- One cubic millimeter of blood contains *7000-8000 of leucocytes* (WBC).
- There are at least *five different types of WBC* which can be distinguished on the basis of the shape of the nucleus and density of granules in the cytoplasm.
- *Granulocytes* include neutrophils eosinophils and basophils they are formed in the red bone marrow.
- *Agranulocytes* are formed in lymphoid, tissue, such as those of the lymph nodes, spleen, tonsils, adenoids and the thymus. Agranulocytes include monocytes and lymphocytes (B and T).





- **Monocytes** stay from 10-20 hours in the blood, then enter tissues and become tissue macrophages performing phagocytic function.
- **Lymphocytes** have life spans of months or even years; but this depends on the body's need for these cells.
- Monocytes and neutrophils travel through capillaries.
- **Basophils** produce heparin, a substance that inhibits blood clotting. These also produce chemicals such as histamine that participates in allergic reaction and in response to tissue damage and microbial invasion.
- **Platelets** are fragments of large cells called megakaryocytes.

## Types Of Blood Cells

FEATURE	RBC	WBC	PLATELETS
Name	Erythrocytes	Leucocytes	Thrombocytes
Colour	Red	Colourless	Colourless
Formation	Liver & spleen (embryonic life), red bone marrow of sternum, ribs, vertebrae (adult life)	Red bone marrow & lymphatic system	Red bone marrow
Size	8 $\mu$	Larger than RBC	Small than RBC
Shape	Biconcave	Different	Plate like
Number(in mm <sup>3</sup> of blood)	5-5.5 million (male), 4-4.5 million (female)	7000-8000	250,000
Structure	Elastic cell membrane, no nucleus, 95% Hb, 5% enzymes, salts, proteins	Nucleus	No nucleus, membrane bounded Cytoplasmic fragments of cells
Life span	4 months (120 days)	Variable	-
Function	Transport of gases	Immunity	Blood clotting

## Types Of WBC

Feature	Neutrophils	Eosinophils	Basophils	Monocytes	Lymphocytes
Size in relation of RBC	Twice	Twice	Twice	Twice to thrice	Slightly larger
Nucleus	2-5 lobed	Bilobed	Bilobed	Round to lobed	Round, nearly filling cell
%age	62%	2%	1%	3%	32%
Function	Destruction of small particles by phagocytosis	Inactivate inflammation producing substances & attack parasites	Release heparin to prevent blood clots & histamin to cause inflammation	Destroy large particles by phagocytosis, form tissue macrophages 10-20 hrs after production	Immune response by producing antibodies





### BLOOD DISORDERS

#### **Leucaemia**

- It is the result of uncontrolled production of WBC (leucocytes). This is caused by a cancerous mutation of a myelogenous or lymphogenous cell.
- It is characterized by increased number of abnormal white cells in the peripheral blood.

#### **Thalassaemia**

- It is also called Cooley's anemia on the name of Thomas B. Cooley American pediatrician.
- It is a genetically transmitted haemoglobin abnormality.
- It is characterized by the presence of microcytes by splenomegaly (enlargement of spleen) and by changes in the bones and skin.
- In thalassaemia, haemoglobin molecule in most cases does not have  $\beta$ -chains in it, instead F<sub>1</sub> chains is present (F is foetal haemoglobin)

#### **Oedema**

- Means the presence of excess fluids in the tissue of the body. The excess fluids may be in the cell or outside the cell.
- It may be an intracellular or extracellular oedema:

#### **Intracellular Oedema**

- Caused by osmosis of water in the cells.
- Leads to depression of metabolic system.

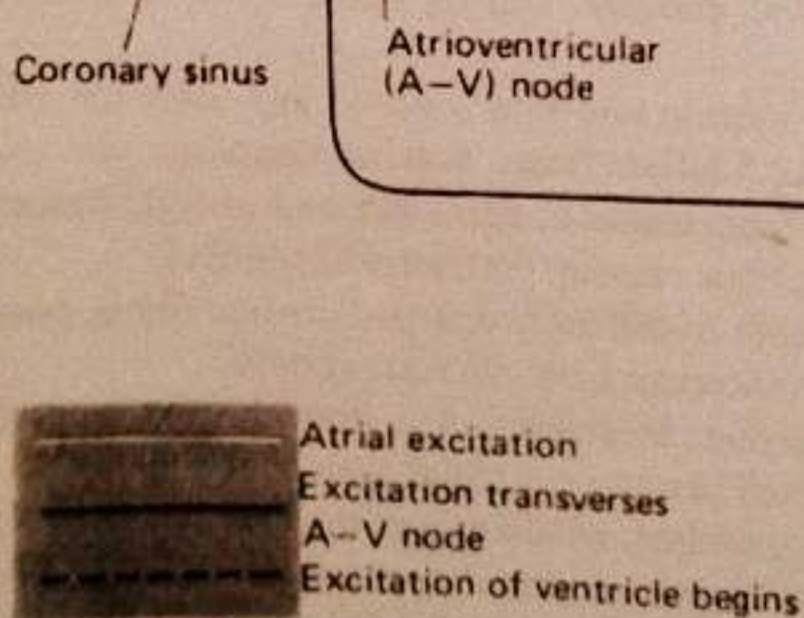
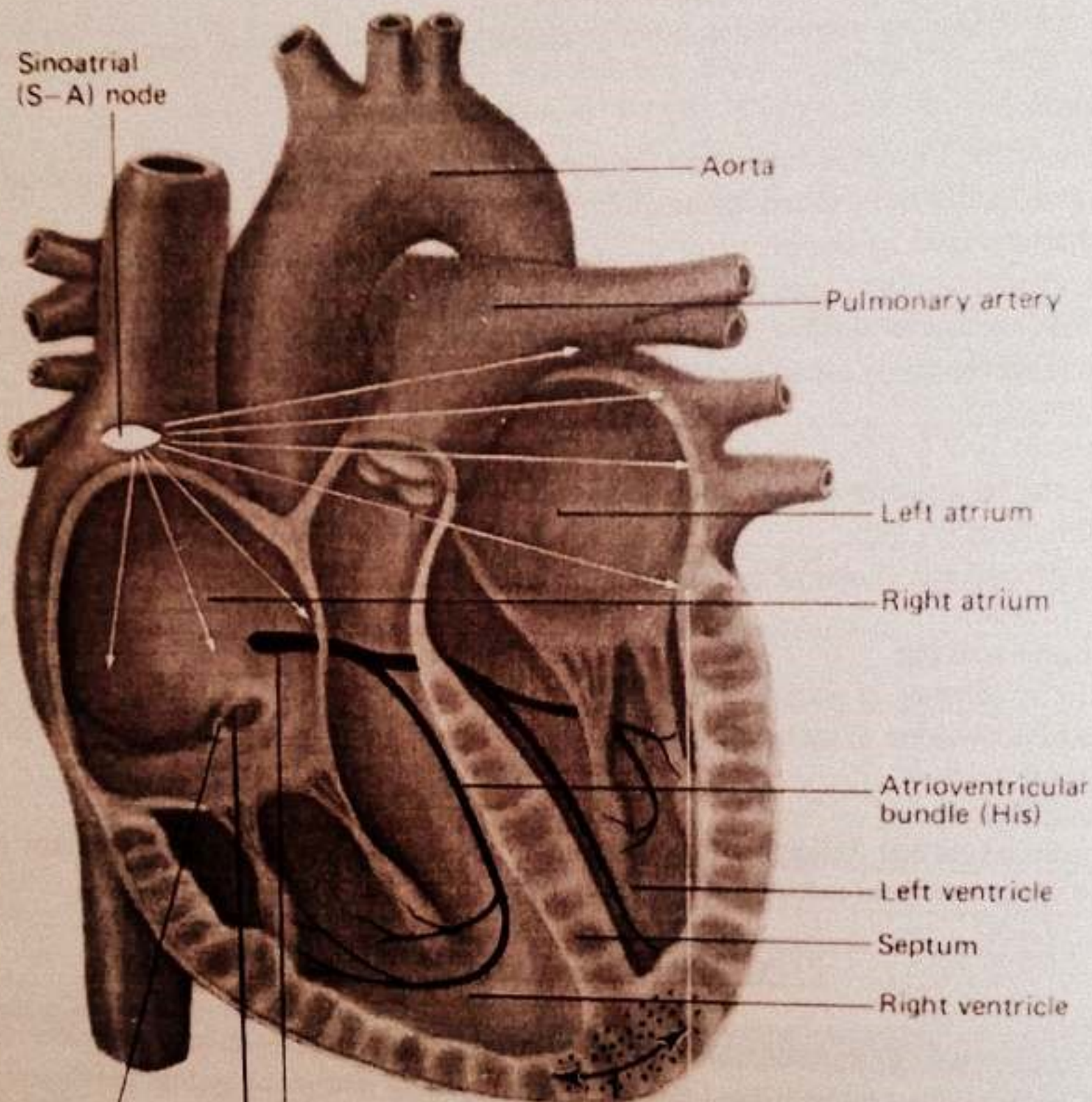
#### **Extracellular Oedema**

Results from abnormal leakage of fluid from blood capillaries, ineffective drainage by the lymphatic system or renal retention of salts and water.

### PUMPING ORGAN - THE HEART

- The walls of left ventricle are thicker (about 3 times) than that of right ventricle.
- Heart beat involves three distinct stages i.e. atrial systole, ventricular systole and diastole.
- Relaxed period of heart chambers is called *diastole*. During this period, atria have more pressure than the ventricles.
- One complete *heartbeat* consists of one systole and one diastole and lasts for about 0.8 seconds. In one's life heart contracts about 2.5 billion times, without stopping.
- Heartbeat starts when the sino-atrial node (pacemaker at the upper end of right atrium sends out electrical impulses to the atrial muscles, thus causing both atria to contract.
- The *sino-atrial node* consists of small number of diffusely oriented cardiac fibres, possessing few myofibrils and few nerve endings from the autonomic nervous system.
- There is a delay of approximately 0.15 seconds in conductance from the S-A node to A-V node, permitting atrial systole to be completed before ventricular systole begins.
- *Pacemaker* is responsible for initiating the impulses, which trigger the heartbeat rate.
- Failure of interatrial foramen (an opening in the interatrial septum) to close or of ductus arteriosus to fully constrict results in cyanosis (blueness of skin) of newborn. This is due to mixing of blood between two atria and the mixed blood is supplied to the body of newborn babies resulting in blueness of skin-thus the name *blue babies*.







BLOOD VESSELS

FEATURE	ARTERY	VEIN	CAPILLARIES
Function	Transports blood away from heart to body parts	Transports blood from body parts to heart	Link arteries with veins
Function	All carry O <sub>2</sub> -blood except pulmonary artery.	All carry de-O <sub>2</sub> blood except pulmonary vein	They have mixed O <sub>2</sub> and de-O <sub>2</sub> blood.
Valves	No valves except at base of pulmonary trunk and aorta	Valves are present	Valves are absent.
Pulse	It can be detected	No pulse	No pulse
Blood flow	Rapid blood flow. It decreases from aorta (400-500 mm/sec) to arteries and arterioles.	It increases from smaller to larger veins.	Slowest blood flow (less than 1mm/sec).
Bore and thickness	Smaller bore and thick walls	Larger bore and thin walls	Larger bore and single cell thick wall
Muscular and elastic tissue	Thick muscular and elastic fibers.	Thin muscle layer and less elastic fibers.	No muscle or elastic fibers.
Elasticity	Highly elastic	Less elastic	No elasticity
Exchange of materials	No exchange	No exchange	Responsible for exchange

**DISORDERS OF BLOOD VESSELS****Atherosclerosis**

- **Atherosclerosis** is coexistent with atheroma and arteriosclerosis i.e. deposition of hard yellow plaque of lipid material in the inner most layer of the arteries, may be due to high level of cholesterol in the blood.
- **Arteriosclerosis** is a degenerative arterial change associated with advancing age. Primarily a thickening of middle layer of arteries and usually associated with some degree of atheroma.
- Atherosclerosis causes narrowing and hardening of arteries. This increases the risk of formation of thrombus and if thrombus is formed in the brain or heart, it is fatal; so atherosclerosis is a major condition leading to heart attack.

**Hypertension or High Blood Pressure**

- It is the measure of force with which blood pushes up against blood vessel. This pressure is generated by the contraction of ventricles (Ventricle systole) and is the highest in aorta and then gradually reduces in arteries.





## Chapter 14

- The pressure reaching its high point during systole (*systolic pressure* which in normal individuals is 120mmHg) and its low point during diastole (*diastolic pressure* which in normal individuals ranges between 75-85 mmHg)
- **Hypertension** is a condition of high blood pressure.

**Thrombus and Thromboembolism**

- It is a solid mass or plug of blood constituents (clot) in a blood vessel.
- It may be dislodged to be carried to some other location in the circulatory system, in which case it is called an embolus.
- **Thromboembolism** is leading cause of death in western civilization.

**Myocardial Infarction**

Blockage of blood vessel in the heart by an embolus or locally formed thrombus causes necrosis or damage to portion of heart muscles, a condition known as a **heart attack** or technically myocardial infarction.

**Haemorrhage**

It is the discharge of blood from blood vessels.

**LYMPHATIC SYSTEM**

- This system is responsible for the **transport and returning of material** from the tissues of the body to the blood.
- It **comprises of** lymph capillaries, lymph vessels, lymphoid masses, lymph nodes, and lymph.
- **Lymph** is the fluid which flows in the system.
- The **lymph vessels** empty in veins; so lymph is a fluid in transit between interstitial fluid and the blood.
- The **intercellular spaces** in the walls of lymph vessels are larger than those of the capillaries of blood vascular system.
- Masses of connective tissue where lymphocytes are present are called **lymph nodes**. Lymph nodes are present in neck region, axilla and groin of humans.
- In an average person, about three litres more fluid leaves the blood capillaries than is absorbed by them each day.
- After a fatty meal, there fat globules may make up 1% of the lymph.
- **Lacteals** are the branches of lymph capillaries inside villi of intestine.

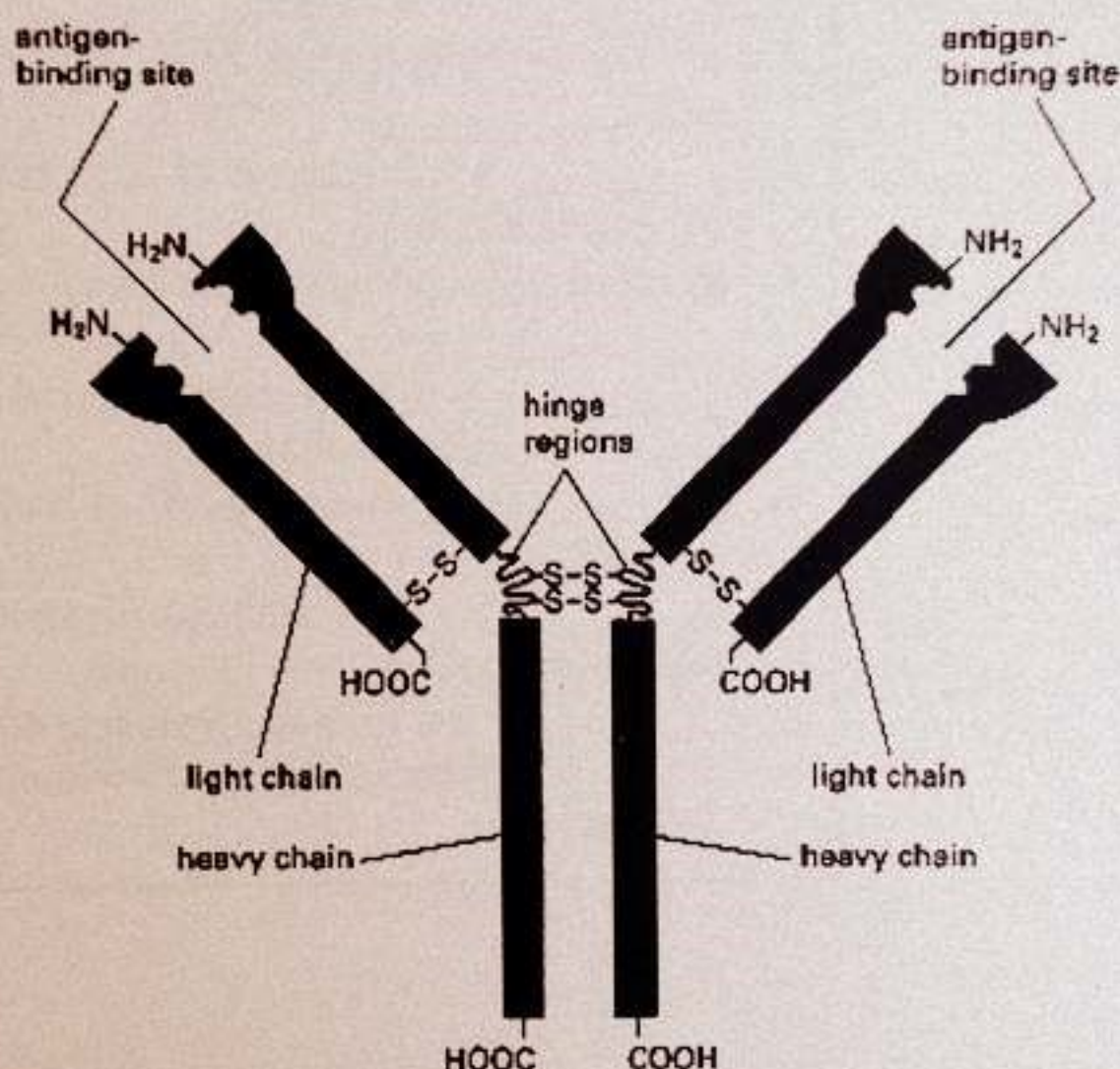
**FUNCTIONS OF LYMPHATIC SYSTEM**

- Return of excess intravascular fluid and proteins to the blood.
- Absorption of large fat globules by lacteals of villi.
- Play important role in the defense system of the body. Lymphocytes and macrophages present inside lymph nodes kill bacteria and viruses.



IMMUNITY AND ITS TYPES

- The capacity to recognize the intrusion of any material foreign to the body and to mobilize cells and cell products to help remove the particular sort of foreign material with great speed and effectiveness is called **immunity**.
- **Antigen** or immunogen is a foreign substance, often a protein which stimulates the formation of antibodies.
- **Antibodies** are manufactured by B-lymphocytes, then secreted into the lymph and blood where they circulate freely.

**Types Of Immunity**

- T-cells recognize antigen and then combat microorganisms and / or effect the rejection of foreign tissue (in case of tissue transplant). This is called **cell mediated response**.
- B-cells recognize antigen and form plasma cell clone. These plasma cells synthesize and liberate antibodies into the blood plasma and tissue fluid. Here antibodies attach to the surfaces of bacteria and speed up their phagocytosis or combine with and neutralize toxins produced by micro-organisms, by producing antitoxins. This is called **humoral immune response**.
- The use of vaccines, which stimulates the production of antibodies in the body, and making a person immune against the diseases or infection is called **active immunity**. But this active immunity has been achieved by artificially introducing, antigens in the body, so it is called **artificially induced active immunity**.
- When a person is exposed to an infection (antigen) becomes ill and in most cases survives then this immunity, developed against that disease is called **naturally induced immunity** or **auto immune response**.
- In **passive immunity**, antibodies are injected in the form of antisera to make a person immune against a disease.





- Passive immunity response is immediate, but not long lasting.
- The method of passive immunization is used to combat active infections of tetanus, infectious hepatitis, rabies, snakebite venom etc.
- In the case of snakebite venom passive immunity is produced by antitoxins so the serum is called antivenom serum.



1. The weight of blood in our body is about \_\_\_\_\_ of our body.
2. 95% of the cytoplasm of RBC is red pigment called \_\_\_\_\_.
3. \_\_\_\_\_ are fragments of large cells called megakaryocytes.
4. Relaxed period of heart chambers is called \_\_\_\_\_.
5. \_\_\_\_\_ is a degenerative arterial change associated with advancing age.
6. \_\_\_\_\_ is a condition of high blood pressure.
7. \_\_\_\_\_ are the branches of lymph capillaries inside villi of intestine.
8. \_\_\_\_\_ is a foreign substance, often a protein which stimulates the formation of antibodies.

**Answers:** (1)  $1/12^{\text{th}}$  (2) Hb (3) Platelets (4) Diastole (5) Arteriosclerosis (6) Hypertension (7) Lactals (8) Antigen





----- VALUES -----

Property	Value
Water potential of pure water	0
KPa =	1000 Pascal
Tension due to transpiration can pull water upto	200 meter (600 feet)
Maximum extent of bleeding in plants in 24 hours	10-15 litres
Speed of movement of water in tall trees	8 m/h
Rate of speed of movement in other plants	1 m/h
Root pressure	100-200 Kpa exceptionally 300 Kpa
Rate of transpiration doubles for every rise of	10C
Temperature for closure of stomata	40-45C
Dry matter of phloem sap	10-25%
Amount of sucrose in dry matter of phloem sap	90%
Nitrogenous compounds in phloem sap	1%
Weight of blood in our body	1/12
Volume of plasma	55%
Volume of blood cells	45%
Role of albumin in colloidal osmotic pressure	75%
Role of globulins in colloidal osmotic pressure	25%
Systolic pressure	120 mmHg
Diastolic pressure	75-85 mmHg
Fat globules in lymph after fatty meal	1%





## PRACTICE EXERCISE

 35 mins  
Time Yourself

- (1) There are \_\_\_\_\_ types of nutrients needed by plants besides light to carry out photosynthesis
  - (a) Two
  - (b) Three
  - (c) Four
  - (d) Five
- (2) The site/s where most of the uptake of water and minerals take place is/are
  - (a) Root hairs
  - (b) Root cells
  - (c) Underground stem
  - (d) All of these
- (3) The uptake of water in plants involves
  - (a) Active transport
  - (b) Passive transport
  - (c) Both of these
  - (d) None of these
- (4) The membrane of vacuoles is known as
  - (a) Vacuoloplast
  - (b) Tonoplast
  - (c) Tanoplast
  - (d) All of these
- (5) The diffusion of ions along with water also takes place by mass flow system along the \_\_\_\_\_ path
  - (a) Tonoplast
  - (b) Apoplast
  - (c) Symplast
  - (d) Vacuolar
- (6) Active transport is dependent on
  - (a) Photosynthesis
  - (b) Respiration
  - (c) Photophosphorylation
  - (d) None of these
- (7) In plants, the neighbouring cells are connected with one another by.
  - (a) Plasmodesmata
  - (b) Cell walls
  - (c) Vacuoles
  - (d) Both 'a' & 'b'
- (8) In the root cells \_\_\_\_\_ pathway becomes discontinuous in the endodermis due to the presence of casparian strip.
  - (a) Tonoplast
  - (b) Apoplast
  - (c) Symplast
  - (d) Vacuolar.
- (9) Cytoplasmic strands that extend through pores in adjacent cell walls are known as
  - (a) Pseudopods
  - (b) Symplasts
  - (c) Plasmodesmata
  - (d) Pili
- (10) In plants, water potential is determined by major factors.
  - (a) Three
  - (b) Four
  - (c) Two
  - (d) Five.
- (11) The pressure generated when water enters & inflates plant cells is called \_\_\_\_\_ potential
  - (a) Water
  - (b) Osmotic
  - (c) Pressure
  - (d) Solute
- (12) The movement of water molecules from a region of higher water potential to a region of lower water potential (through membrane)
  - (a) Diffusion
  - (b) Osmosis
  - (c) Active transport
  - (d) None of these.





- (13) \_\_\_\_\_ potential is the measure of the change in water potential of a system due to the presence of solute molecules.
- (a) Osmotic (b) Pressure  
(c) Both of these (d) None of these.
- (14) Solute potential is always
- (a) +ve (b) -ve  
(c) +ve or -ve (d) Zero
- (15) \_\_\_\_\_ component of cell wall has great affinity with water.
- (a) Lignin (b) Cellulose  
(c) Pectin (d) All of these.
- (16) Commonly in other plants than tall ones the speed of upward movement of water is
- (a)  $8\text{mh}^{-1}$  (b)  $1\text{mh}^{-1}$   
(c)  $7\text{mh}^{-1}$  (d)  $4\text{mh}^{-1}$
- (17) Exceptionally the positive hydrostatic pressure generated by root pressure is about
- (a) 600 KPa (b) 800 KPa  
(c) 1000 KPa (d) 900 KPa
- (18) Cuticular transpiration is \_\_\_\_\_ of total transpiration
- (a) 6-8% (b) 5-7%  
(c) 7-9% (d) 4-6%
- (19) All plants do not possess
- (a) Lenticels (b) Cuticle  
(c) Stomata (d) All of these
- (20) Lenticular transpiration is \_\_\_\_\_ of total transpiration
- (a) 2-3% (b) 1-3%  
(c) 1-4% (d) 1-2%
- (21) Aerating openings formed in the bark through which exchange of gases takes place and water is lost in the form of vapours are
- (a) Hydathods (b) Stomata  
(c) Lenticels (d) None of these
- (22) Lenticels look like
- (a) A big pore (b) Stoma  
(c) Sponge (d) Cars or small protusions
- (23) Stomatal transpiration is \_\_\_\_\_ of total transpiration
- (a) 90% (b) 91%  
(c) 93% (d) 95%
- (24) They function as multisensory hydraulic valve
- (a) Lenticels (b) Guard cells  
(c) Hydathods (d) All of these
- (25) There are \_\_\_\_\_ hypothesis which may explain opening and closing of stomata
- (a) One (b) Two  
(c) Three (d) Four
- (26) Stomata open due to \_\_\_\_\_ of  $\text{K}^+$  into the guard cells from the surrounding epidermis
- (a) Diffusion (b) Active transport  
(c) Osmosis (d) All of these
- (27) Low level of  $\text{CO}_2$  favours \_\_\_\_\_ of the stomata
- (a) Opening (b) Closure  
(c) Both of these (d) None of these



- (28) The opening and closing of stomata is directly controlled by the  
 (a) Temperature (b) pH  
 (c) Light (d) None of these
- (29) Symbionts which help plants in uptake of phosphorus and trace metals such as zinc and copper.  
 (a) Bacteria (b) Fungi  
 (c) Fungi (d) Cyanobacteria
- (30) Transport of minerals from soil to epidermal cells of roots via carrier protein molecules along their concentration gradient is called:  
 (a) Diffusion (b) Facilitated diffusion  
 (c) Passive transport (d) Active transport
- (31) Pulling upward of water and dissolved minerals towards the leaves through the xylem tissue is called  
 (a) Transpiration pull (b) Root pressure  
 (c) Ascent of sap (d) All of these
- (32) Pressure flow theory was proposed by  
 (a) H-Van Mohl (b) Dixon  
 (c) Vander wall (d) Earnst Munch
- (33) A pressure created by active secretion of salts and other solutes from other cells into xylem sap is called  
 (a) Transpiration pull (b) Root pressure  
 (c) Osmotic pressure (d) None of these
- (34) Addition of salts and other solutes from other cells into xylem sap, \_\_\_\_\_ the water potential of the xylem sap  
 (a) Increases (b) Lowers  
 (c) Doesn't effect (d) Maintains
- (35) Open circulatory system can contain  
 (a) Red Blood Cells (b) White Blood Cells  
 (c) Haemoglobin (d) All of these
- (36) Which of the following is true about hearts of earthworm?  
 (a) There are 5-7 pairs of heart  
 (b) They are present between 1-7<sup>th</sup> segments  
 (c) They are present lateral to the oesophagus  
 (d) They pump blood from ventral to dorsal vessel
- (37) Single circuit heart is found in  
 (a) Fishes (b) Amphibians  
 (c) Reptiles (d) Mammals
- (38) It has been estimated that in a normal person plasma constitutes about \_\_\_\_\_ by volume of blood.  
 (a) 35% (b) 45%  
 (c) 55% (d) 75%
- (39) 95% of the cytoplasm of red blood cells is the  
 (a) Antibodies (b) Haemoglobin  
 (c) Enzymes (d) Proteins
- (40) \_\_\_\_\_ give rise to macrophages, which destroy larger particles by phagocytosis.  
 (a) Neutrophils (b) Basophils  
 (c) Monocyte (d) Lymphocyte



- (41) Which of the following are proteins in nature?  
 (a) Antibodies. (b) Interferons  
 (c) Antitoxins (d) All of these
- (42) Cooley's anemia is another name used for  
 (a) Leucemia (b) Thalassemia  
 (c) Sickle cell anemia (d) None of these
- (43) Tricuspid valve is present  
 (a) Between right atrium and right ventricle  
 (b) Between left atrium and left ventricle  
 (c) At base of pulmonary artery  
 (d) At base of aorta
- (44) QRS complex represents  
 (a) Atrial systole (b) Ventricular systole  
 (c) Atrial diastole (d) Ventricular diastole
- (45) Which of the following have thickest walls?  
 (a) Arteries (b) Veins  
 (c) Capillaries (d) None of these
- (46) It is the measure of force with which blood pushes up against the walls of blood vessels.  
 (a) Stroke volume (b) Cardiac output  
 (c) Blood pressure (d) Blood flow
- (47) All of the following are blood clots except  
 (a) Thrombus (b) Embolus  
 (c) Atheroma (d) Hematoma
- (48) It is the discharge of blood from blood vessels.  
 (a) Myocardial infarction (b) Cerebral infarction  
 (c) Cerebral Hemorrhage (d) Thromboembolism
- (49) The flow of lymph is maintained by  
 (a) Movement of viscera (b) Breathing movements  
 (c) Valves (d) All of these
- (50) Introduction of vaccine within the body to produce immunity is an example of  
 (a) Artificially induced active immunity (b) Naturally induced active immunity  
 (c) Artificially induced passive immunity (d) Naturally induced passive immunity



## SCIENTISTS WITH THEIR ACHIEVEMENTS

Year	Scientist	Achievement
1795	Edward Jenner	First vaccination against small pox
1997	Scientist of Scotland	First clone of sheep
	F. Sanger	First sequence of amino acid in insulin
1870	F. Miescher	Nucleic acid from nuclei of pus cells
1951	Erwin Chargaff	Equal ratios of nitrogenous bases
	Wilkin & Franklin	X-ray diffraction of DNA
	Watson & Crick	Physical structure of DNA
1890	Emil Fischer	Lock & key model of enzyme action
1939	Koshland	Induce fit model
1665	Robert Hooke	Discovery of cell, micrographia
1805	Lorenz Oken	Living organisms having vesicles or cells
1809	J. B. de Lamarck	No life without cellular tissue
1831	Robert Brown	Discovery of nucleus
1838	Schwann & Schleiden	<ul style="list-style-type: none"> <li>• Cell theory</li> <li>• Nucleus + Cytoplasm + Cell membrane</li> </ul>
1855	Rudolph Virchow	New cell by division of previous cells
1862	Louis Pasteur	<ul style="list-style-type: none"> <li>• Experimental proof of Virchow's hypothesis</li> <li>• First time used word vaccination</li> <li>• Vaccine for anthrax, fowl cholera &amp; rabies</li> <li>• Pasteurization</li> <li>• Microorganisms as cause of disease</li> </ul>
1880	August Weismann	Common origin & basic similarities
1898	Golgi	Discovery of Golgi complex
1949	De Duve	Discovery of lysosome & peroxisomes
1955	Palade	Discovery of ribosomes
1778	Carolus Linnaeus	Binomial nomenclature
1884	Charles Chamberland	Identified viruses as filterable substances
1886	Earnst Haeckel	<ul style="list-style-type: none"> <li>• Three kingdom classification (3<sup>rd</sup> kingdom protista)</li> <li>• Separation of blue green algae &amp; bacteria from protista into monera</li> </ul>
1892	Ivanewski	First time isolated viruses in pure form
1915	Twort & D'Herelle	Discovered bacteriophages & called them as bacteria eater
1932	Stanely	Purified & crystallized TMV
1937	E. Chaffon	Two kingdom classification (Procariotique & Eucariotique)
1969	Robert Whittaker	Five kingdom classification
1968	Margulis & Schwartz	<ul style="list-style-type: none"> <li>• Modification in 5 kingdom classification</li> <li>• Placed unicellular eukaryote in protista</li> <li>• 27 phyla for protista</li> </ul>





1673	Leeuwenhoek	Small creatures as 'animalcules'.
	Robert Koch	<ul style="list-style-type: none"> <li>Discovered bacteria of anthrax, TB &amp; cholera</li> <li>Technique for inoculation, isolation, media preparation, maintenance of pure culture &amp; preparation of specimens</li> <li>Germ theory of disease</li> </ul>
	Hans Christian Gram	Gram staining + Gram positive & negative bacteria
1861	John Hogg	Proposed kingdom protista for microscopic organisms
1938	Herbert Copeland	Separating prokaryote from protista & elevating then to kingdom status
	Halbur	Pig as source of hepatitis E
1673	Leeuwenhoek	Small creatures as 'animalcules'
	Robert Koch	<ul style="list-style-type: none"> <li>Discovered bacteria of anthrax, TB &amp; cholera</li> <li>Techniques of inoculation, isolation, media preparation, maintenance of pure culture &amp; preparation of specimens</li> <li>Germ theory of disease</li> </ul>
	Hans Christian Gram	Gram staining of bacteria
1930	Van Neil	Water as source of oxygen
1883	T.W.Engelmann	First action spectrum in spirogyra
1961	Melvin Calvin	Calvin cycle of photosynthesis
	Dixon	Cohesion tension theory
1874	Sacks	Imbibition
1930	Ernst Munch	Pressure flow theory
	Thomas B. Cooley	Thalassaemia



## DIAGNOSTIC TEST &amp; PART-I

## DIAGNOSTIC TEST

1	B	11	C	21	D	31	C	41	D	51	C	61	D
2	B	12	A	22	D	32	C	42	B	52	C	62	C
3	C	13	C	23	B	33	D	43	B	53	A	63	C
4	C	14	D	24	C	34	B	44	C	54	C	64	B
5	C	15	C	25	C	35	C	45	A	55	D	65	C
6	C	16	D	26	D	36	D	46	B	56	C	66	C
7	B	17	B	27	C	37	B	47	A	57	C	67	A
8	D	18	B	28	C	38	B	48	C	58	B	68	C
9	C	19	D	29	D	39	D	49	B	59	B	69	D
10	C	20	C	30	D	40	C	50	A	60	B	70	A

## CHAPTER-1

1	C	11	D	21	C	31	B
2	C	12	B	22	C	32	D
3	A	13	B	23	C	33	D
4	C	14	C	24	D	34	C
5	B	15	B	25	D	35	D
6	B	16	B	26	B	36	D
7	A	17	B	27	A	37	D
8	B	18	A	28	B	38	B
9	D	19	B	29	C	39	C
10	C	20	C	30	D	40	B

## CHAPTER-2

1	B	11	C	21	A	31	C	41	B	51	D	61	C	71	A
2	C	12	B	22	C	32	B	42	C	52	A	62	B	72	C
3	A	13	B	23	B	33	B	43	B	53	C	63	B	73	A
4	D	14	B	24	D	34	C	44	D	54	C	64	C	74	C
5	C	15	A	25	A	35	C	45	A	55	B	65	C	75	B
6	D	16	B	26	B	36	C	46	C	56	A	66	C	76	B
7	C	17	A	27	C	37	B	47	C	57	A	67	D	77	B
8	D	18	D	28	C	38	B	48	B	58	B	68	B	78	B
9	C	19	C	29	A	39	A	49	A	59	C	69	C	79	C
10	C	20	C	30	B	40	D	50	A	60	B	70	B		



**CHAPTER-3**

1	D	11	D	21	D
2	C	12	B	22	C
3	C	13	C	23	A
4	D	14	B	24	C
5	A	15	A	25	A
6	C	16	C		
7	B	17	C		
8	A	18	C		
9	B	19	B		
10	A	20	C		

**CHAPTER-4**

1	C	11	A	21	C	31	D	41	C
2	C	12	D	22	C	32	D	42	C
3	B	13	B	23	A	33	A	43	B
4	A	14	D	24	B	34	A		
5	B	15	C	25	A	35	A		
6	D	16	C	26	C	36	A		
7	C	17	C	27	A	37	D		
8	C	18	B	28	D	38	C		
9	B	19	C	29	C	39	C		
10	A	20	D	30	A	40	B		

**CHAPTER-5**

1	C	11	D	21	C	31	C	41	C
2	D	12	C	22	C	32	C	42	B
3	C	13	B	23	B	33	A	43	B
4	B	14	C	24	D	34	A	44	C
5	A	15	A	25	A	35	B	45	C
6	D	16	B	26	B	36	A		
7	C	17	D	27	C	37	D		
8	D	18	B	28	B	38	D		
9	D	19	C	29	D	39	B		
10	C	20	B	30	C	40	C		





## CHAPTER-6

1	D	11	C	21	D	31	C
2	D	12	B	22	A	32	B
3	A	13	B	23	A	33	D
4	C	14	D	24	D	34	B
5	D	15	D	25	B	35	A
6	C	16	A	26	B	36	A
7	C	17	D	27	A	37	B
8	C	18	D	28	C	38	B
9	C	19	B	29	D	39	A
10	B	20	B	30	B	40	B

## CHAPTER-7

1	B	11	A	21	B
2	D	12	B	22	A
3	B	13	A	23	A
4	B	14	A	24	C
5	D	15	B	25	C
6	B	16	D	26	B
7	B	17	D	27	A
8	A	18	A	28	D
9	A	19	A	29	A
10	A	20	B	30	D

## CHAPTER-8

1	B	11	C	21	B	31	A
2	B	12	A	22	D	32	B
3	D	13	C	23	D	33	B
4	D	14	C	24	C	34	B
5	A	15	B	25	B		
6	B	16	C	26	D		
7	C	17	A	27	A		
8	C	18	D	28	B		
9	C	19	B	29	C		
10	C	20	C	30	D		



CHAPTER-9

1	D	11	C	21	B	31	C	41	D
2	B	12	C	22	C	32	C	42	B
3	A	13	D	23	A	33	C	43	C
4	A	14	D	24	B	34	B	44	C
5	B	15	C	25	D	35	A	45	B
6	B	16	B	26	C	36	C	46	A
7	C	17	A	27	B	37	B	47	B
8	B	18	D	28	C	38	D	48	B
9	A	19	A	29	C	39	D	49	B
10	A	20	A	30	D	40	A	50	A

CHAPTER-10

1	C	11	D	21	B	31	C	41	B	51	D	61	B
2	B	12	B	22	B	32	A	42	A	52	B	62	A
3	D	13	D	23	A	33	C	43	C	53	D	63	D
4	A	14	A	24	B	34	B	44	D	54	A	64	B
5	C	15	B	25	C	35	A	45	B	55	C	65	D
6	C	16	A	26	A	36	D	46	B	56	C		
7	A	17	C	27	C	37	B	47	C	57	C		
8	C	18	C	28	D	38	A	48	A	58	D		
9	B	19	C	29	A	39	A	49	B	59	B		
10	B	20	D	30	B	40	C	50	D	60	B		

CHAPTER-11

1	C	11	A	21	A	31	B	41	C	51	A
2	C	12	C	22	A	32	C	42	B	52	D
3	B	13	D	23	B	33	A	43	D	53	A
4	C	14	D	24	C	34	B	44	A	54	C
5	B	15	D	25	A	35	D	45	A	55	D
6	B	16	D	26	D	36	D	46	B		
7	A	17	A	27	A	37	A	47	C		
8	C	18	A	28	B	38	D	48	C		
9	D	19	C	29	A	39	C	49	D		
10	B	20	D	30	C	40	C	50	B		



CHAPTER-12

1	D	11	B	21	B	31	C
2	C	12	B	22	B	32	D
3	D	13	A	23	B	33	A
4	C	14	A	24	C	34	B
5	B	15	B	25	B	35	C
6	B	16	C	26	A		
7	B	17	B	27	B		
8	C	18	C	28	C		
9	D	19	B	29	D		
10	B	20	C	30	A		

CHAPTER-13

1	B	11	D	21	B	31	B
2	A	12	D	22	B	32	C
3	A	13	A	23	D	33	C
4	C	14	B	24	D	34	D
5	A	15	B	25	A	35	A
6	B	16	D	26	C		
7	C	17	C	27	D		
8	B	18	B	28	D		
9	C	19	B	29	C		
10	C	20	B	30	A		

CHAPTER-14

1	B	11	C	21	C	31	A	41	D
2	A	12	B	22	D	32	D	42	B
3	B	13	A	23	A	33	B	43	A
4	B	14	B	24	B	34	B	44	B
5	B	15	D	25	B	35	B	45	A
6	B	16	B	26	B	36	C	46	C
7	D	17	B	27	A	37	A	47	C
8	B	18	B	28	C	38	C	48	C
9	C	19	A	29	C	39	B	49	D
10	C	20	D	30	B	40	C	50	A



KIPS ENTRY TEST SERIES

# Part - II

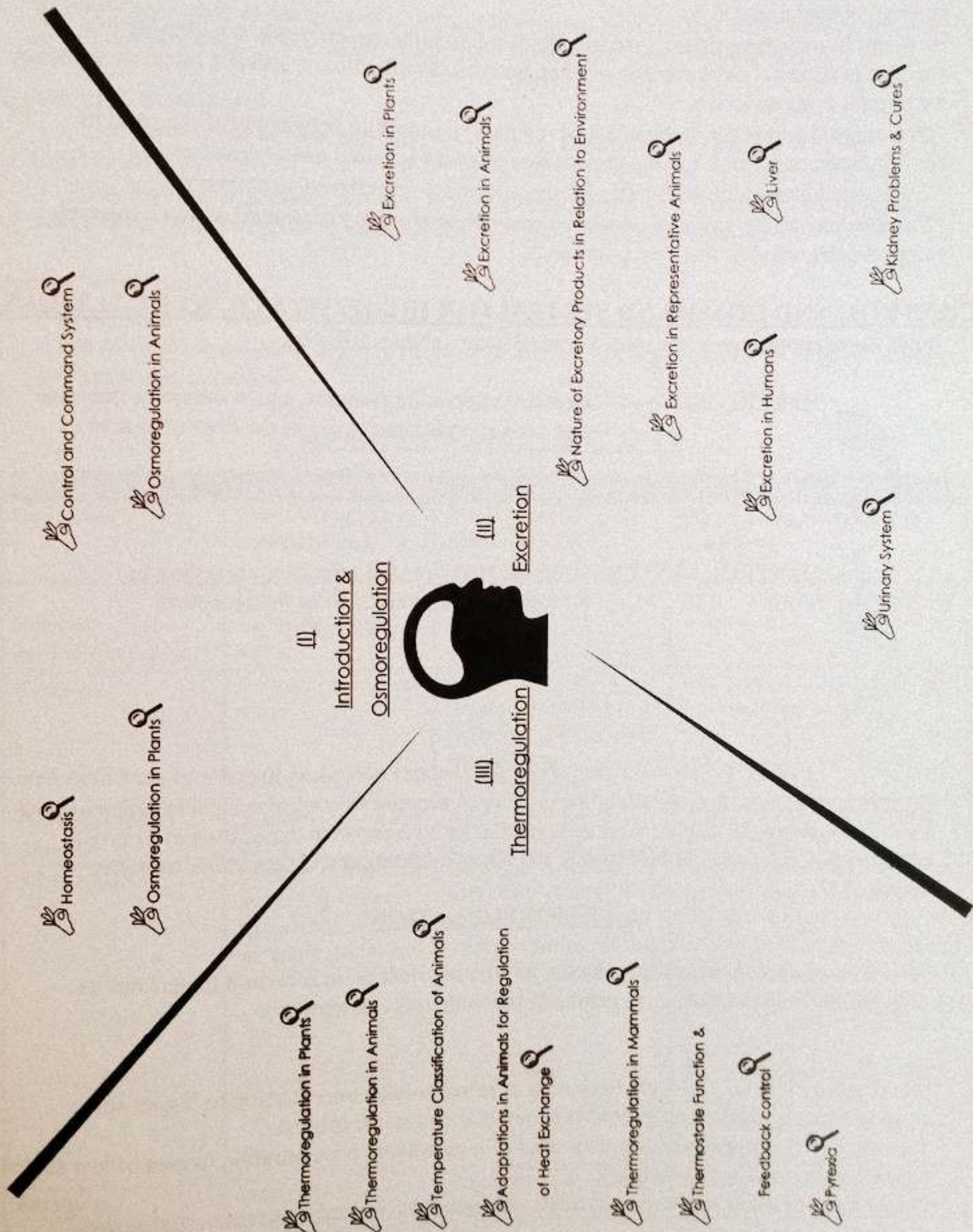
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# Chapter 15

## HOMEOSTASIS



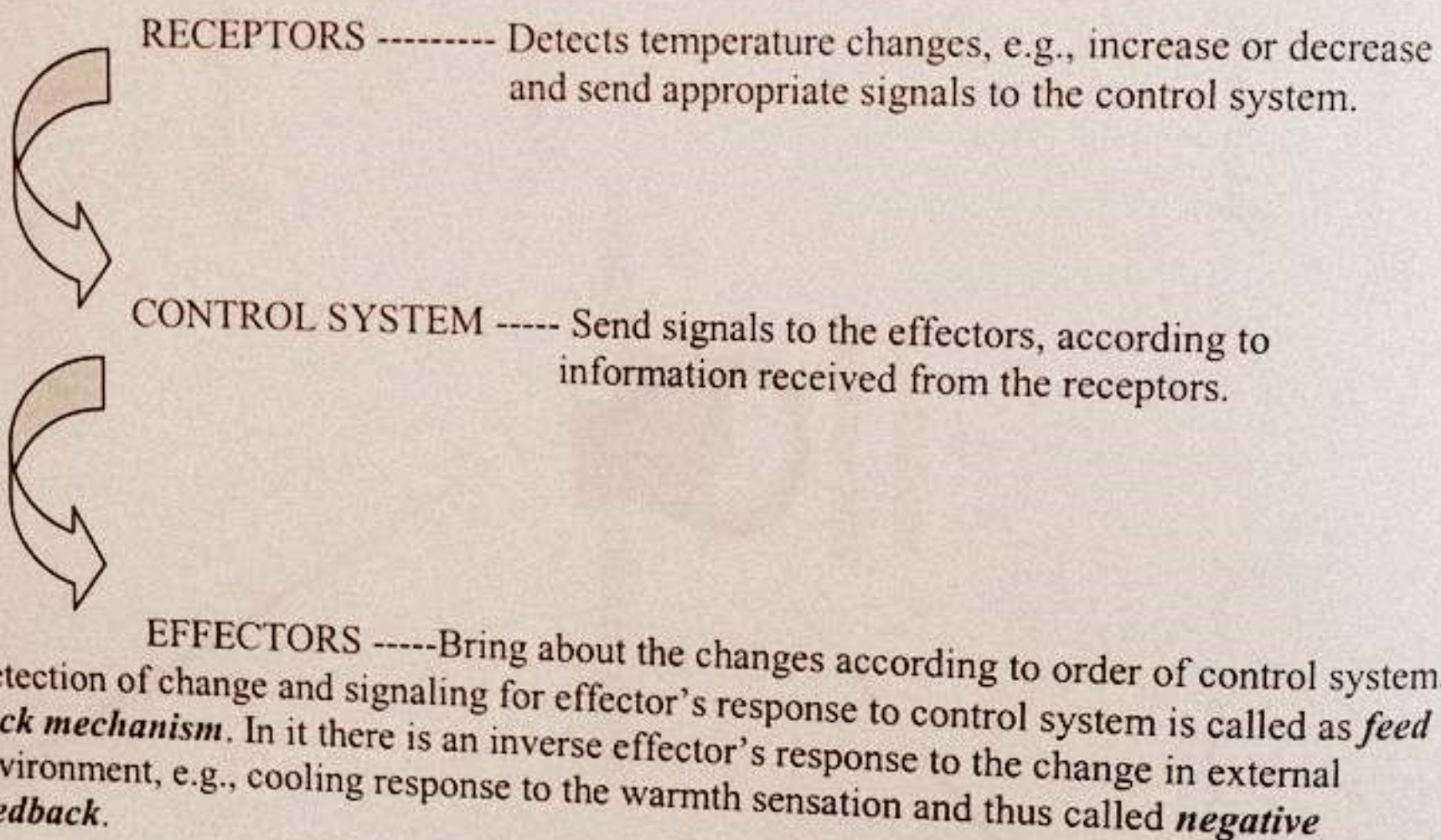


CONCEPTS IN OSMOREGULATION

- “**Homeostasis** is the protection of internal environment from the harms of fluctuations in the external environment.”
- However homeostasis doesn't mean to keep a fixed internal environment, despite of wide changes in external environment, as changes maintained within a specific range as necessary for normal body function.
- “**Osmoregulation** is the mechanism of regulation, generally between organism and its environment, of solutes and the gain or loss of water is called osmoregulation.
- “The mechanism which eliminates nitrogenous waste is referred as excretion.”
- “The mechanism by virtue of which internal temperature is maintained within a tolerable range is designated as thermoregulation.”

CONTROL AND COMMAND SYSTEM FOR HOMEOSTATIC REGULATIONS

- It has *three components*: receptors, control centre and an effector.

OSMOREGULATION

All the cells are adapted to defined quantity of water in relation to salts in it to perform its function. Homeostatic mechanisms generally maintain this concentration.

**Osmosis**

- “Movement of water molecule from area of lower solute concentration to higher solute concentration through semi-permeable membrane is called osmosis.”
- “Movement of water molecules from area of high solvent concentration to area of low solvent concentration is called osmosis.”
- “Movement of water molecules from high water potential to low water potential is called osmosis.”



**Hypotonic Environment**

- A solution, whose solute concentration is lower, means a *diluted solution*, is called hypotonic.
- *A cell in hypotonic solution* swells, its turgidity increases and eventually bursts since water enter from surrounding low solute medium to intracellular higher solute media.

**Hypertonic Environment**

- A solution whose solute concentration is higher i.e. *concentrated solution* is called hypertonic.
- *A cell in hypertonic solution* shrinks, since water molecules move from intracellular higher solute concentration media to extracellular lower solute concentration media.

**Isotonic Environment**

- A solution whose solute concentration is similar as that of the cell present in it.
- *A cell in isotonic solution* will remain same, since the solute concentration is same in intra and extracellular media.

**OSMOREGULATION IN PLANTS**

FEATURE	HYDROPHYTES	MESOPHYTES	XEROPHYTES
<b>Definition</b>	Plants living in an aquatic habitat.	Plants living in moderately dry terrestrial locality.	Plants living in severely dry conditions.
<b>External environment</b>	Hypotonic, maximum supply of water	Moderate supply of water	Dry, minimum supply of water
<b>Danger</b>	Excess entry of water	Variability in water supply, swelling in sufficient supply, and dehydration in restricted supply.	Decreased supply and increased loss of water
<b>Osmoregulatory strategy</b>	Remove excess water	Adapt according to environment.	Water storage & decreased loss of water
<b>Adaptations</b>	Surface area of leaves is large + Extensive stomata on upper surface of leaves	Stomatal opening in sufficient supply to enhance the losses, while, closing during restricted supply to prevent the losses.	Small, thick leaves reducing surface area to volume. + Thick, waxy & leathery cuticle + Stomata on lower surface of leaves & in depressions + Shedding of leaves (cacti) to restrict transpiration, with Photosynthetic stem + water storage in stems in rainy seasons to use it in dry season.
<b>Examples</b>	Water lily etc	Brassica, rose, mango etc	Cactus etc



OSMOREGULATION IN ANIMALS

- Animal cells require more critical balance.
- Animals that do not require active adjustments to their internal osmotic state are called *osmoconformers*. Their body fluids are kept at isotonic concentration even in extreme hypertonic environment e.g., some marine water fishes.
- Animals that actively regulate their internal fluid and salts concentration are called *osmoregulators*. These are in danger of osmotic variation in different aquatic conditions.

FEATURE	MARINE WATER	FRESH WATER	TERRESTRIAL
Environment	Hypertonic	Hypotonic	Dry
Danger	Excess entry of salt + loss of water	Excess entry of water, and loss of salts.	Evaporative loss of water leading to dehydration.
Adaptations			
Invertebrates	Mostly osmoconformers	Contractile vacuole in amoeba & paramecium, which pumps excess water.	Arthropods & others having waxy exoskeleton
Vertebrates	<i>Hagfishes</i> (isotonic with surrounding sea water.), <i>Cartilaginous fishes</i> (maintain lower internal salt concentration + active salt excretion through kidneys via gills & rectal glands (special salt excretory organs) + retention of hypertonic agents like trimethylamine oxide, since cant retain urea for this purpose bec. Of toxicity, <i>Bony fishes</i> (drink large amount of sea water + excrete concentrated urine)	<i>Fishes</i> (Large volumes of dilute urine + Preference of salt containing food + active uptake of salts by gills & skin results in compensation of excessive salt loss.)	Multi-layered dead keratinized skin cells + drinking & eating moist food + metabolic & behavioral adaptations like eating seeds of desert plants containing carbohydrates thus producing metabolic water (kangaroo rat) + concentrated urine + anhydrobiosis ( the process of tolerating dehydration)





1. The mechanism which eliminates nitrogenous waste is referred as \_\_\_\_\_.
2. Detection of change and signaling for effector's response to control system is called as \_\_\_\_\_.
3. A solution whose solute concentration is higher i.e. concentrated solution is called \_\_\_\_\_.
4. Animals that actively regulate their internal fluid and salts concentration are called \_\_\_\_\_.
5. Dilute urine is produced by \_\_\_\_\_ animals.

### EXCRETION

- "The elimination of wasteful metabolites, mainly of the nitrogenous nature is called excretion."

#### **In Animals**

Carbohydrates & lipids

→  $\text{CO}_2$  &  $\text{H}_2\text{O}$

(Metabolize to)

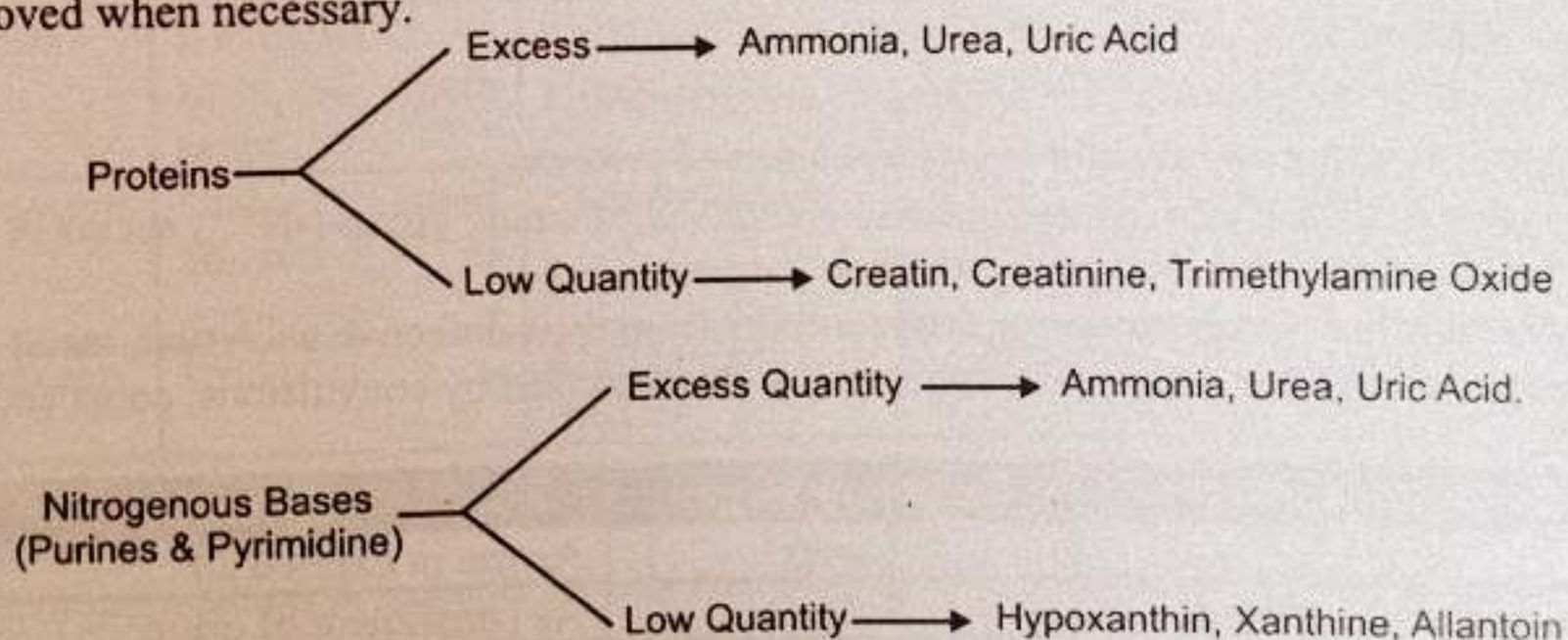
Proteins & nucleoproteins

→ Nitrogenous waste (Toxins thus must be eliminated)

(Metabolize to)

#### **In Plants**

- $\text{O}_2$  is waste product of photosynthesis.
- $\text{CO}_2$  and  $\text{H}_2\text{O}$  are excretory products of respiration.
- **Organic and inorganic compounds** which may be stored for various purposes and then removed when necessary.



Answers: (1) Excretion (2) Feedback Mechanism (3) Hypertonic (4) Osmoregulators (5) Freshwater





## Chapter 15

EXCRETION IN PLANTS

Waste	Structures Involved For Excretion/ Storage	Mechanism Involved
Oxygen	Stomata	Eliminated in environment
CO <sub>2</sub>	Stomata	Eliminated in environment
Water	Stomata	Transpiration, or used to maintain the turgor.
Crystallizing wastes	Vacuole.	Stored in vacuoles, at a concentration that leads to crystal formation in these vacuoles.
Inorganic & organic wastes	Leaves	Accumulate in leaves, which fall in autumn thus plants get rid of accumulated waste. For this reason leaves are called excretophore.
Strange chemicals	Old xylem of branches & trunk, that no longer carry water.	Production of black wood in the center as in ebony
Chemical waste materials	-	Excreted directly into soil, occasionally using them as a chemical weapons against other competing plants e.g., conifers.

- **Yellow colour of fallen leaves** is not because of loss of chlorophyll as thought, instead their microscopic examination revealed that they are filled with pigmented compounds and toxic material as heavy metals.

EXCRETION IN ANIMALS

Various excretory substances produced in animals are as follows:

- **Water** removed in hyper osmotic environment.
- **Salts** as an excretory product in hypertonic environment.
- **Nitrogenous waste** metabolites from catabolism of proteins.
- In amino acid catabolism, **de-amination** i.e. removal of amino group (-NH<sub>2</sub>) occurs or its transfer takes place for storage or excretion purposes.
- Elevated level of nitrogenous products, resulting from their defective excretion, result in their accumulation in brain causing encephalopathy characterized by convulsions, coma and even death.

Excretory product	Excretory Organ	Remarks
CO <sub>2</sub>	Lungs	As gas in expired air
Mineral salts, nitrogenous waste products mainly urea	Kidney	As constituent of urine
	Skin	As constituent of sweat, though only in small amount.
Excess water	Kidney	As main component of urine
	Skin	As main component of sweat
	Lung	As water vapours in expired air
Bile Pigments (from Hb breakdown)	Liver	In feces.





### NATURE OF EXCRETORY PRODUCTS IN RELATION TO HABITAT

- *Ammonia* being very toxic, must be kept at very low concentration which is achieved by dissolving it in large amount of water, which is possible in hypotonic environment e.g., available to fresh water organisms.
- In limited water supply this is not possible, so other alternatives of ammonia are excreted like *urea* which requires less water. Ammonia is converted to urea by Urea Cycle.
- *Ureotelic and uricotelic* are evolutionary adaptations of nitrogenous waste in the habitat of terrestrial animals.

Habitat	Water supply	Nitrogenous waste	Toxicity	Amount of water/ 1g N to be excreted.	Related Terms For Animals	Examples
Aquatic	Maximum	Ammonia	Most toxic	500ml/1gN	Ammonotelic	Hydra, planaria
Terrestrial	Moderate	Urea	Less toxic	50ml/1gN (1/10 that of ammonia)	Ureotelic	Human
Terrestrial	Minimum	Uric acid	Least toxic	1ml/1gN	Uricotelic	Reptiles, birds

### EXCRETION IN REPRESENTATIVE ANIMALS

Animal	Excretory Product	Excretory Structure	Mechanism
Hydra	Ammonia	Not any specialized	Excretion simply through diffusion
Planaria	Ammonia in form of dilute urine	Protonephridia (flame cells)	Waste > Flame cell > Tubular system > Excretory duct > Nephridiopore > Outside
Earthworm	Urea + small amount of ammonia	Metanephridia	Waste > Coelomic fluid > Nephrostome > Tubule > Nephridiopore > Outside
Cockroach	Uric acid	Malpighian tubules	Hemolymph in sinuses > Wastes > Malpighian tubule > Rectum > Outside

#### **Excretion In Planaria**

- *Protonephridium* is a simple tubular excretory system of planaria, a flatworm, consisting of closed tubules without internal opening.
- *Flame cell* is a cellular setup capped with the branches of protonephridium. It contains a tuft of cilia, which when beat, resemble a flickering flame, thus called flame cell. Their beating pushes the interstitial fluid into tubular system.



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## Excretion in Earthworm

- *Metanephridia* are the excretory organs of earthworm.
- Each segment has a pair of metanephridia.
- *Nephrostome* is an internal ciliated opening, immersed in coelomic fluid and enveloped by network of capillaries. It collects coelomic fluid.
- Absorption of useful minerals and salts take place as the fluid pass through these tubules, resulting in formation of left over, the nitrogenous wastes, which are expelled out through *nephridiopore*.

## Excretion in Cockroaches

- *Malpighian tubules* are the excretory structures of insects, consisting of suspended tubular structures, which collect excretory products (nitrogenous wastes) from hemolymph in the sinuses.
- They are the only excretory structures which are *associated with hind gut* thus excrete wastes with the feces.
- *Salts and nitrogenous wastes* in hemolymph removed by epithelial lining of these tubules, pass to the gut, where most of the salts and water get further reabsorbed, resulting in excretion of nitrogenous waste(uric acid) along the feces.

EXCRETION IN HUMANS

## Metabolic Wastes

Waste material produced as a result of various metabolic reactions in the body e.g.

- Urea -----from metabolism of amino acids.
- Creatine ----- from muscle creatine.
- Uric acid----- from metabolism of nucleic acid.
- Bilirubin----- end product of Hemoglobin breakdown .
- Metabolites ----of various hormones.
- Toxins ----- produced in the body, + those ingested e.g., as pesticides, drugs and food additives.

## Excretory Organs

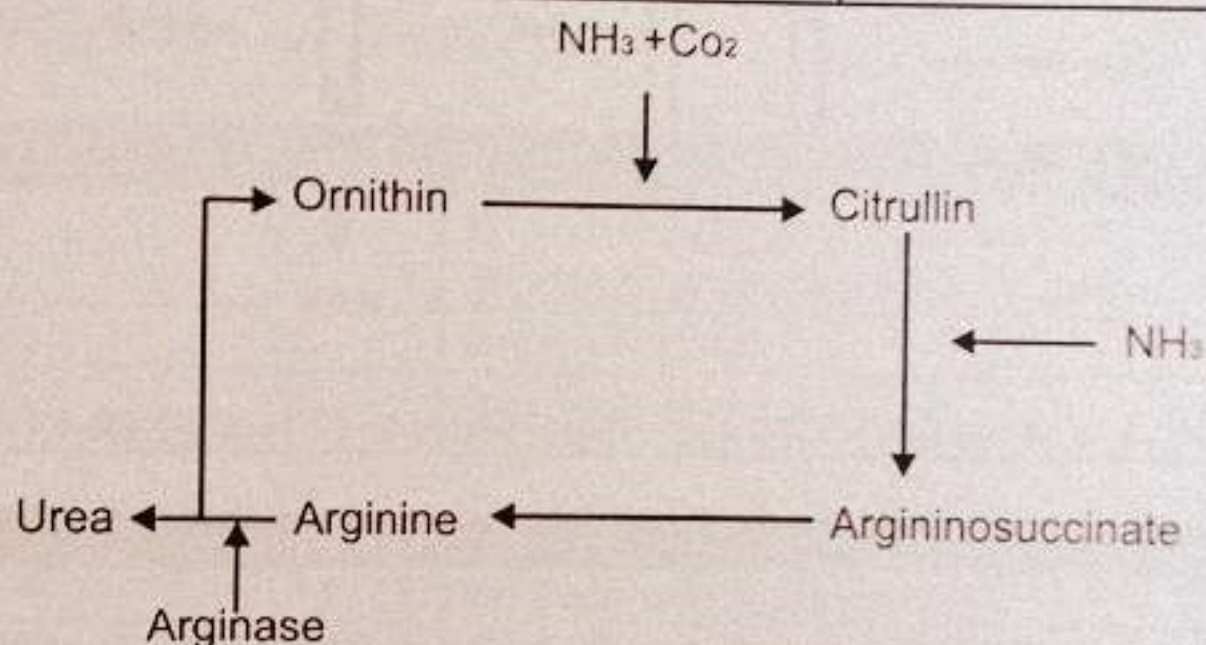
- *Liver and kidneys* are the chief excretory organs.
- *Skin* is not an excretory organ, although it removes water in sweat and salts in sebum, but water removal in sweat is an example of thermoregulation, while salt excretion in sebum is for protection against microbes.

## Liver

- Liver is the *chief metabolic organ* of the body
- It supports the excretory role of the kidneys by detoxifying many chemical poisons, and produce ammonia, urea and uric acid from nitrogen containing compounds.
- Urea is synthesized via urea cycle, in which two ammonia and one CO<sub>2</sub> molecules are shunted into the cycle to generate one molecule of urea.
- Some homeostatic functions performed by liver are as follows:



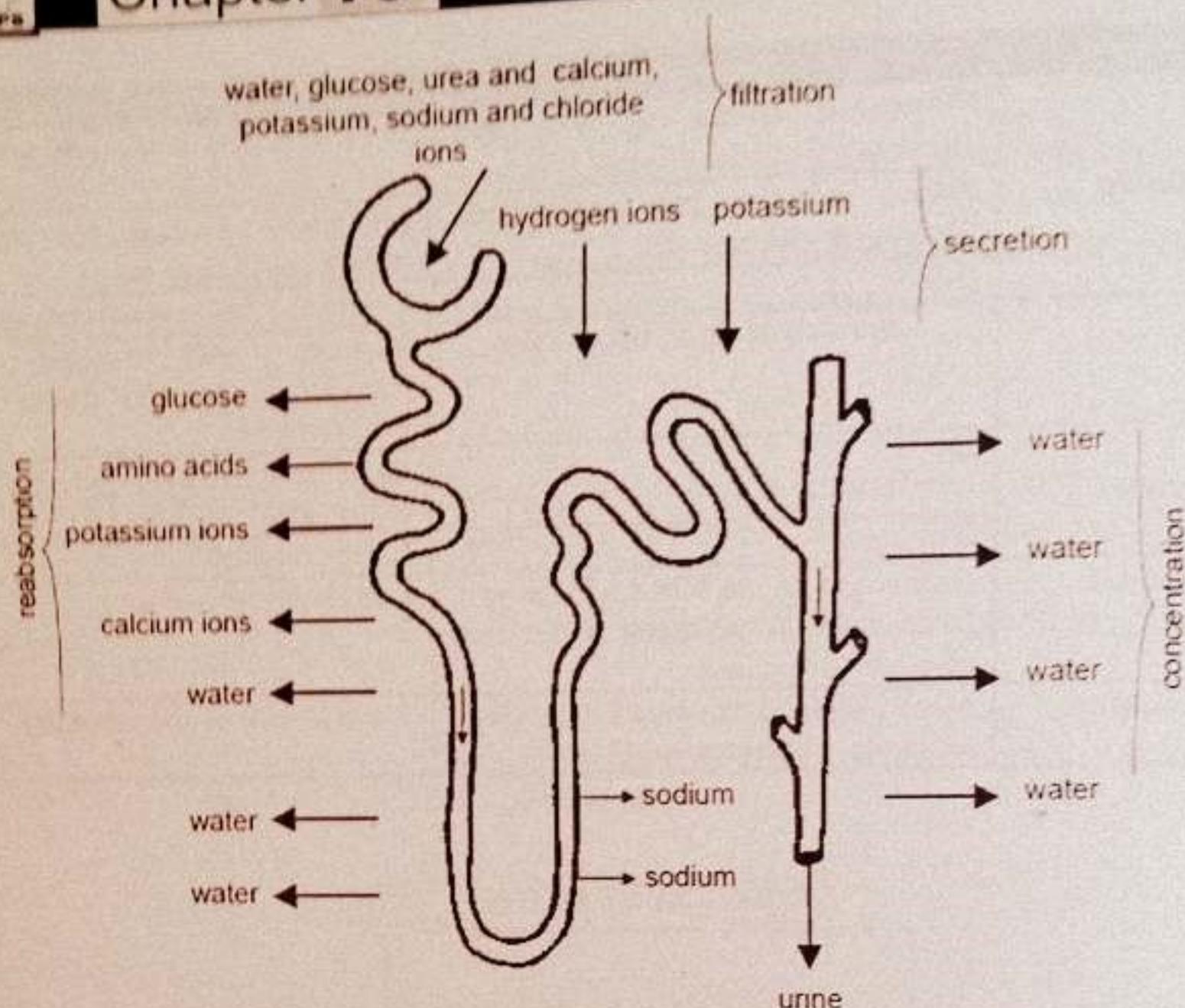
Function	Function	Major Effects on Homeostasis
Synthesis	Nitrogenous wastes e.g. $\text{NH}_3$ , urea, uric acid	Support kidney in waste disposal
	Plasma proteins like prothrombin, fibrinogen, albumin etc.	(a) blood clotting (b) maintain osmotic balance of blood
	Bile	Emulsifies fats in small intestine
	Lipids, cholesterol, lipoproteins	Regulate blood chemistry, store energy and help to maintain cell membranes
Storage	Iron	Oxygenation of tissues as constituent of haemoglobin
	Glycogen	Energy reserves
Conversion	Excess glucose in blood to glycogen, lactic acid to glycogen and stored glycogen to glucose	Energy storage and use
Detoxification	Many harmful chemicals e.g. food additives, pesticides, drugs etc.	Assist kidney in toxin disposal



### Urinary System

- **Kidneys** are not only one of the *major excretory organs* of humans but also act as an *osmoregulator*.
- Each kidney accounts for just **1 % of the body weight**, while it receives 20% of blood supplied with each cardiac out put.
- Basic functional unit of a kidney is called **nephron**.
- Nephrons may be **cortical or juxtramudullary**.
- Those nephrons that are present along the border of cortex and medullas, with tubular system looping deep in inner medulla are called **juxtamedullary nephrons**.
- Juxtamedullary nephrons play important role in production of concentrated urine.





### STRUCTURAL COMPONENTS OF NEPHRON WITH THEIR FUNCTION

Structure	Function
Bowman's capsule	Formation of Bowman's filtrate
Glomerulus	Ball of capillaries, receives blood from afferent arterioles & distributes to efferent arterioles. Glomerular walls are porous with slightly high blood pressure. It is involved in <i>pressure filtration</i> .
Peritubular network	Network of capillaries around tubular part
Proximal convoluted part	Reabsorption of all useful constituents of glomerular filtrate
Loop of Henle	Aldosterone acting on its thick loop.
Distal convoluted part	Reabsorption of water.
Collecting tubules	Reabsorption of water under action of ADH
Vasa recta	Concentration of urine in case of juxtamedullary nephron.

### Maintaining The Concentration Of Urine And Production Of Concentrated Urine

- In *restricted water supply*, kidneys excrete concentrated urine conserving most of the water (which may result from 99.5% of reabsorption of Glomerular filtrate in a mammalian kidney) ----- Regulated by counter current and hormonal mechanisms.
- In *excessive water supply*, kidneys excrete dilute urine, an adaptation to ensure excessive water excretion.----- Regulated by inhibition of release of Antidiuretic Hormone.

### Counter- Current Multiplier

- The solute concentration gradually increases as we move from cortex to medulla.
- It maintains a high solute concentration in medulla.





- There is a gradual osmotic outflow of water from filtrate back to kidney as it moves downwards in the descending loop of Henle, since it is permeable to water, but not to salts.
- Ascending limb does not allow outflow of water from its filtrate, instead actively transport  $\text{Na}^+$  into kidney interstitium to sustain its high concentration (controlled by aldosterone.)
- Counter current multiplier plays the pivotal role in production of hypertonic (concentrated) urine in mammals including humans.

### Hormonal Control

- *Aldosterone* is secreted by adrenal cortex, regulates the uptake of  $\text{Na}^+$  in the ascending limb.
- *Anti diuretic hormone (ADH)* is secreted from posterior pituitary, actively transports water from filtrate in collecting tubule back to kidney.

## KIDNEY PROBLEMS AND CURE

### KIDNEY STONES

- Stone formation in kidney and urinary tract, results in obstruction to flow of urine, increases susceptibility to infection and thus eventually to kidney failure.
- Different types of kidney stones are as follows:

TYPE OF STONE	%AGE	CAUSE
Calcium oxalate	70%	Hyperoxaluria (higher blood level of oxalates oxalates present in green vegetables & tomatoes)
Calcium phosphate	15%	Hypercalcemia
Uric acid	10%	Increased uric acid level

### Cure

- *Lithotripsy* is applied for smaller stones.
- *Extracorporeal shock wave lithotripsy* is the one opted for kidney stones. This is a minimal invasive surgery, in which kidney, pelvic or ureteric stones are broken down by bombarding ultrasounds or X- rays on them without giving any cut.
- Smaller stone pieces are flushed through ureter and then through urethra out of the body.
- *Kidney surgery* is done for larger stones which can't be broken by lithotripsy technique. Direct surgical exposure and removal of stone is done.

### RENAL FAILURE

- Failure of all the kidney functions i.e., excretory, osmoregulatory, hormonal (secretion of erythropoietin--- helps in RBC formation) and metabolic function is called renal failure.
- Nephrons are destroyed particularly at glomerular part, leading to accumulation of urea, other waste materials, bone weakening and anemia.

### Cure

It is either dialysis or kidney transplantation.

- The process of artificially removing urea is called *dialysis*.
- The waste material, e.g. urea from the blood, either by pass kidneys through an artificial kidney (dialysis machine) or filtering it within the abdomen.
- Dialysis is of two types i.e. peritoneal dialysis and hemodialysis.
- *Peritoneal dialysis* uses the peritoneum (inner lining of abdomen) to filter the blood present in peritoneal blood vessels.





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- Peritoneal cavity is filled with dialysis solution. Waste materials having high concentration in blood are filtered through peritoneum into the peritoneal cavity containing dialyzing solution, which is removed afterwards.
- Hemodialysis means cleaning the blood.
- Waste material in blood are filtered by passing it through a machine which contains a dialyzer also called *artificial kidney*.
- It is made of two spaces separated by a thin membrane. Blood flows inside the membrane in one direction and dialyzing fluid out side the membrane in another direction.

## Renal Transplant

- It is considered permanent treatment. Since dialysis can only be done on temporary basis.
- Mostly opted in severe renal failure, called uremia or end-stage renal disease.
- Only a matched kidney can be transplanted in an individual.



1. In plants, \_\_\_\_\_ are considered as excretophore.
2. \_\_\_\_\_ and \_\_\_\_\_ are evolutionary adaptations of nitrogenous waste in the habitat of terrestrial animals.
3. \_\_\_\_\_ are the excretory organs of earthworm.
4. \_\_\_\_\_ is the chief metabolic organ of the body.
5. \_\_\_\_\_ is secreted by adrenal cortex, regulates the uptake of  $\text{Na}^+$  in the ascending limb.
6. The process of artificially removing urea is called \_\_\_\_\_.

THERMOREGULATION

"The mechanism by virtue of which internal temperature is maintained within a tolerable range is designated as thermoregulation."

## THERMOREGULATION IN PLANTS

TO HIGH TEMPERATURE	
Harmful Effects	Adaptations
<ul style="list-style-type: none"> <li>• Excessive heat stress.</li> <li>• Denaturation of enzymes and damage to metabolism.</li> </ul>	<ul style="list-style-type: none"> <li>• Evaporative cooling.</li> <li>• Synthesis of heat shock proteins.(embraces enzymes and other proteins and thus prevent denaturation.)</li> </ul>
TO LOW TEMPERATURE	

(1) Leaves (2) Uricoly & Uricolely (3) Metanephridia (4) Liver  
(5) Aldosterone (6) Dialysis

ANSWERS:



- |  |  |
|--|--|
| <ul style="list-style-type: none"> <li>• Alteration in fluidity of cell membrane resulting from locking of membrane lipids in crystalline form effecting the transport of solutes.</li> <li>• Effect on structure of membrane proteins.</li> <li>• Ice crystal formation in protoplasm at freezing temperature resulting in membrane and organelles perforation and even death.</li> </ul> | <ul style="list-style-type: none"> <li>• Increasing proportion of unsaturated fatty acids thus preventing crystal formation. This a time requiring adaptation.</li> <li>• Changes in solute composition of the cells causing cytosol to supercool without ice formation, although ice crystal may form at cell wall( not so hazardous.)</li> </ul> |
|--|--|

### THERMOREGULATION IN ANIMALS

Temperature of an animal	Depends upon	Rate of change of body heat
Rate of change of body heat	Depends upon	<ul style="list-style-type: none"> <li>• Rate of metabolic heat production</li> <li>• Rate of external heat gain.</li> <li>• Rate of heat loss</li> </ul>
External heat gain	Via	<ul style="list-style-type: none"> <li>• Infra-red &amp; thermal radiation.</li> <li>• Direct &amp; reflected sunlight</li> </ul>
Heat loss	Via	<ul style="list-style-type: none"> <li>• Radiation</li> <li>• Evaporation</li> </ul>

### TEMPERATURE CLASSIFICATION OF ANIMALS

CLASS	DEFINITION	EXAMPLES
<b>CLASSIFICATION BASED ON HEAT REGULATION</b>		
<b>Poikilotherm</b>	Animals whose body temperature tends to fluctuate with environment.	Invertebrates, amphibians & reptiles.
<b>Homeotherms</b>	The animals which maintain their body temperature, despite of external changes.	Birds & mammals.
<b>Exceptions</b>	Some animals that do not fit in this definition	Deep sea fishes, numerous birds & mammals
<b>CLASSIFICATION BASED ON SOURCE OF HEAT PRODUCTION</b>		
<b>Endotherms</b>	Animals that generate their own body heat through heat production, as a by-product during metabolism.	Birds, mammals, some fishes & flying insects.
<b>Ectotherms</b>	Animals that produce metabolic heat, which get quickly exchanged with the environment, but absorb heat from the surroundings.	Most invertebrates, fish, amphibians & reptiles.
<b>Heterotherms</b>	Those animals that are capable of varying degrees of endothermic heat production but generally do not regulate their body temperature with in a narrow range.	Bats & humming bird.



## ADAPTATIONS IN ANIMALS FOR REGULATION OF HEAT EXCHANGE

STRUCTURAL	PHYSIOLOGICAL	BEHAVIORAL
<ul style="list-style-type: none"> <li>• Sub dermal fatty layer insulation.</li> <li>• Pelage</li> <li>• Sweat glands</li> <li>• Lung modification for panting.</li> </ul>	<ul style="list-style-type: none"> <li>• Regulation of blood flow to skin. (inc. in hot and dec. in cold season)</li> <li>• Activation of muscles causing plumage fluffing.</li> <li>• Activation of sweat glands for evaporative cooling</li> </ul>	<ul style="list-style-type: none"> <li>• Change of habitat where heat exchange is minimal e.g. ground squirrels to burrow in mid day heat and lizards bask in sun to gain heat.</li> <li>• Adjusting posture, thus changing the amount of surface area available.</li> </ul>

### THERMOREGULATION IN MAMMALS (HUMANS)

- Human beings are endothermic organisms thus generate their own body heat through heat production, as a by-product during metabolism. It maintains a high body temperature in between a narrow range of  $36-38^{\circ}\text{C}$ .
- Because of endothermy in birds and mammals
  - High metabolic rate is maintained.
  - Round the clock availability of energy.
  - Greater ability of adaptation
  - Assisted in a wider diversity and distribution.
- Production of heat through increased muscle contraction and shivering is called *shivering thermogenesis*.
- Generation of heat through mechanisms other than shivering for example via thyroid hormones which increases the metabolic rate of body is called *non-shivering thermogenesis*.
- *Brown fat*, present in some mammals, is specialized in rapid heat production.

#### Adaptations In Cold Temperature

- Mammalian *skin* has been adapted as the organ of thermoregulation, via vasoconstrictive responses for example in cold environment to conserve maximum energy and vasodilatational response in hot conditions to facilitate greater heat loss.
- Because of this peripheral vasoconstriction, the skin of extremities like hands and feet are quite cooler than our trunk in a cool day, which contains most of the vital organs.
- Rising of fur in most of the land mammals, can trap the thicker layer of still air which act as a good insulator.
- A thick *layer of fat* beneath the skin, e.g., in humans acts a good insulating material.
- *Marine mammals* like whales and seals inhabit much cooler habitat because of a thick layer of insulating fat called *blubber* just under the skin.

#### Adaptations In Warm Temperature

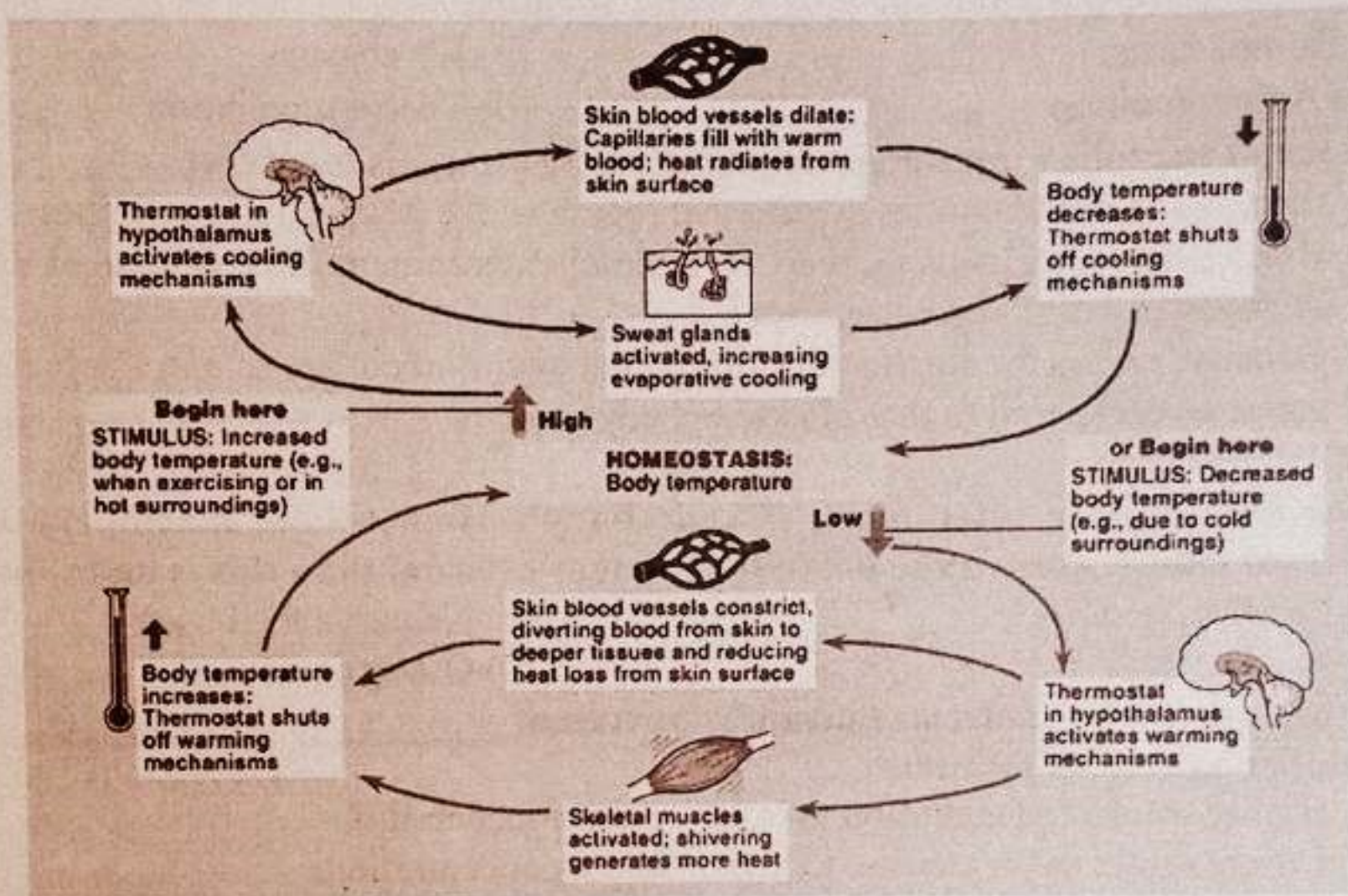
- *Marine mammal*: utilize blood vessels in their outer layer of *skin* to dispose off excess heat.
- *Terrestrial mammals* use *evaporative cooling* and sweat gland activity.
- *Panting* is evaporative cooling through the respiratory tract as in dogs.



- *Bats* use saliva and their urine for evaporative cooling.

## THERMOSTATIC FUNCTION AND FEEDBACK CONTROL

Homeostatic thermostat is present in the hypothalamus, which responds to change in temperature both above and below the set point of  $37^{\circ}\text{C}$ .



## TEMPERATURE IN FEVER (PYREXIA)

- Chemicals produced by pathogens like bacteria, viruses and by cells like leukocytes which displace the set point of thermostat in hypothalamus, above  $37^{\circ}\text{C}$  leading to increase in body temperature are called *pyrogens*.
- This high temperature helps in stimulating the protective mechanism against the pathogens.



1. Animals that generate their own body heat through heat production, as a by-product during metabolism are called \_\_\_\_\_.
2. Production of heat through increased muscle contraction and shivering is called \_\_\_\_\_.
3. \_\_\_\_\_ is evaporative cooling through the respiratory tract as in dogs.
4. Temperature in fever is called \_\_\_\_\_.
5. High temperature in plants causes denaturation of \_\_\_\_\_.



## PRACTICE EXERCISE



1. The mechanism of regulation, generally between organism and its environment, of solutes and the gain and the loss of water is called
  - (a) Homeostasis
  - (b) Hemostasis
  - (c) Osmoregulation
  - (d) Thermoregulation
2. Which of the following statement about Homeostasis is incorrect
  - (a) There is a definite control system that regulates the homeostatic activities
  - (b) Homeostatic mechanisms keep the internal environment fixed despite of wide changes in external environment
  - (c) Because of this the fluctuations of internal environment are of extremely narrow range as compared to that of external environment
  - (d) All are correct
3. In a hot summer after noon, if your body's Homeostatic machinery keep your internal temperature quite lower than that of external than this is an example of
  - (a) Positive feed back
  - (b) Negative feed back
  - (c) Feed back
  - (d) Osmoregulation
4. In osmosis water molecules move from area of \_\_\_\_\_ to \_\_\_\_\_ through semipermeable membrane
  - (a) Higher solute concentration to lower solute concentration
  - (b) Lower solute concentration to higher solute concentration
  - (c) Lower solvent concentration to higher solvent concentration
  - (d) all of these
5. Which of the following represents osmoregulatory steps taken by hydrophytes?
  - (a) Increases transpiration by increasing the surface area of the leave.
  - (b) Small and thick leaves to decrease the surface area proportional to the volume of the leave.
  - (c) Stomata closing in sufficient supply, and opening in restricted supply of water.
  - (d) None of these
6. Thick, waxy & leathery cuticle around leaves is present in
  - (a) Hydrophytes
  - (b) Mesophytes
  - (c) Xerophytes
  - (d) Halophytes
7. Rose is an example of
  - (a) Hydrophytes
  - (b) Mesophytes
  - (c) Xerophytes
  - (d) Halophytes
8. Most of the marine invertebrates are
  - (a) Osmoconformers
  - (b) Osmoregulators
  - (c) Both depend upon the concentration of sea water
  - (d) None of these
9. Which of the following fish drink large amount of sea water and excrete concentrated urine resulting in maximum salt excretion and minimal water loss?
  - (a) Hagfish
  - (b) Fresh water fishes
  - (c) Bony fishes
  - (d) None of these





10. Marine fish can keep their internal environment hypertonic with respect to the surrounding salty water by retaining
  - (a) Excessive urea which will increase their internal solute concentration and prevent body shrinkage in hypertonic environment
  - (b) Trimethyl alanine
  - (c) Ammonia
  - (d) Trimethylamine oxide
11. Which of the following marine fishes are considered direct descendants of fresh water ancestors?
  - (a) Hagfish
  - (b) Jelly Fish
  - (c) Star Fish
  - (d) Bony fishes
12. Which of the following fishes excrete large volume of diluted urine?
  - (a) Bony Marine fishes
  - (b) Fresh water fishes
  - (c) Both depending upon the surrounding water
  - (d) None of these
13. Terrestrial animals like kangaroo rat survive even without drinking water since
  - (a) They don't require water for their metabolic processes
  - (b) They can retain excessive water in their body during raining season
  - (c) They feed on carbohydrate rich seeds which can provide them with metabolic water
  - (d) They are anhydrobiotic organisms
14. The characteristic which enable animals to tolerate dehydration is called
  - (a) Osmoconformation
  - (b) Osmoregulation
  - (c) Anhydrobiosis
  - (d) Anhydrosis
15. Which excretory product is produced in plants during autotrophic mode of life?
  - (a)  $\text{CO}_2$
  - (b)  $\text{H}_2\text{O}$
  - (c)  $\text{O}_2$
  - (d) Both A and B
16. In plants which of the following is a waste product produced both during photosynthesis and respiration
  - (a)  $\text{CO}_2$
  - (b)  $\text{H}_2\text{O}$
  - (c)  $\text{O}_2$
  - (d) Both A and B
17. Which of the following structure in plant's body is called excretophores?
  - (a) Stem
  - (b) Leaves
  - (c) Flowers
  - (d) Roots
18. Which of the following statement about conifers is correct?
  - (a) Stored excretory products in vacuoles, at a concentration that leads to crystal formation.
  - (b) Accumulate waste in leaves, which fall in autumn.
  - (c) Production of black wood in the center.
  - (d) Excrete some of the waste materials directly into soil, occasionally using them as a chemical weapon against other competing plants.
19. In animals excess of nitrogen is excreted primarily in form of
  - (a) Creatinine
  - (b) Trimethylamine oxide
  - (c) Pyrimidine
  - (d) Ammonia
20. Purine and pyrimidine catabolism results in production of
  - (a) Creatinine
  - (b) Trimethylamine oxide
  - (c) Xanthine
  - (d) None of these
21. Which of the following is most toxic?
  - (a) Ammonia
  - (b) Urea
  - (c) Uric acid
  - (d) Trimethylamine oxide





## Chapter 15

22. Aquatic animals excrete nitrogenous waste commonly in the form of  
 (a) Ammonia. (b) Urea  
 (c) Uric acid (d) Trimethylamine oxide
23. Amount of water required to excrete 1gN of Urea is  
 (a) 1 ml (b) 50 ml  
 (c) 100 ml (d) 150 ml
24. Which of the following animal excrete nitrogenous waste mainly as uric acid?  
 (a) Hydra (b) Planaria.  
 (c) Humans (d) Birds.
25. Hydra has no specialized excretory system because  
 (a) It does not produce waste material  
 (b) Due to absence of mesoderm  
 (c) The whole body cells are in contact with water  
 (d) It has pseudocoelom.
26. Each nephridium of earthworm opens to the exterior by  
 (a) Nephrostome (b) Nephridiopore  
 (c) Flame cell (d) Anus
27. The nephridia of earthworm open into the coelom by  
 (a) Nephrostome (b) Nephridiopore  
 (c) Flame cell (d) Anus
28. Which of the following openings have cilia?  
 (a) Nephrostome (b) Nephridiopore  
 (c) Both of these (d) None of these
29. The distal blind end of the malpighian tubules bathes freely in  
 (a) Digestive tract (b) Intestines  
 (c) Haemocoel (d) Coelom
30. The main nitrogenous waste formed in the body of earthworm is/are  
 (a) Ammonia (b) Urea  
 (c) Uric acid (d) Trimethylamine oxide
31. Protonephridia are present in  
 (a) Round worms (b) Flatworm  
 (c) Tape worms (d) Segmented worms
32. Nephrostome in earthworm opens in  
 (a) External space (b) Internal Body cavity  
 (c) In gut (d) In Bladder
33. Which of the following excretory structure is associated with gut of the organism?  
 (a) Protonephridium (b) Metanephridium  
 (c) Malpighian tubules (d) Nephrons
34. Malpighian tubules absorb waste materials and salts from  
 (a) Blood (b) Lymph  
 (c) Gut (d) Hemolymph
35. Which of the following is a segmentally arranged excretory system?  
 (a) Protonephridium (b) Metanephridium  
 (c) Malpighian tubules (d) Nephrons
36. In Urea cycle \_\_\_\_\_ ammonia molecules combine with 1  $\text{CO}_2$  molecule to form 1 molecule of urea.  
 (a) 1 (b) 2  
 (c) 3 (d) 4



37. Excessive lactic acid is converted into \_\_\_\_\_ by liver.  
(a) Glucose (b) Fructose  
(c) Sucrose (d) Glycogen
38. Each human kidney receives \_\_\_\_\_ % of total cardiac output  
(a) 10 % (b) 20 %  
(c) 30 % (d) 40%
39. Which of the following nephrons play important role in production of concentrated urine?  
(a) Cortical (b) Medullary  
(c) Juxtramedullary (d) None of these
40. Which of the vascular channels are related to Juxtramedullary nephrons only?  
(a) Afferent and efferent arterioles (b) Peritubular capillaries  
(c) Vasa nervosa (d) Vasa recta
41. Which of the following filtrate contains excessive amount of amino acids, glucose, and salts?  
(a) Glomerular filtrate  
(b) Filtrate passing through ascending limb  
(c) Filtrate passing through distal convoluted tubule  
(d) Filtrate passing through collecting tubules
42. Which of the following constituent is/are maximum in the filtrate that leaves proximal convoluted tubules  
(a) Glucose (b) Amino acids  
(c) Nitrogenous waste (d) All of these
43. Mammalian kidney, under restricted water supply can conserve water by over \_\_\_\_\_ % reabsorption of glomerular filtrate  
(a) 80.5% (b) 90.5 %  
(c) 95.5% (d) 99.5%
44. On which of the following site the posterior pituitary hormone acts predominantly  
(a) Proximal convoluted tubule (b) Descending limb of loop of Henle  
(c) Ascending limb of loop of Henle (d) Collecting tubules
45. Which of the following kidney stones are most common?  
(a) Calcium oxalate (b) Calcium phosphate  
(c) Uric acid (d) All of these
46. A stone measuring 0.4 cm, blocking the outlet of renal pelvis resulting in mild to moderate tract obstruction. Which of the following technique will be opted to remove this stone  
(a) Kidney surgery  
(b) Burring a hole and removing the stone manually (nephrolithotomy)  
(c) Extracorporeal Shock wave lithotripsy  
(d) None of these
47. Which of the following mechanism explains development of anemia in Renal failure?  
(a) Failure of bone marrow is accompanied with renal failure.  
(b) Destruction of RBC results from accumulated urea in the blood.  
(c) Chronicity of the disease is responsible for anemia  
(d) Failure of proper RBC synthesis, due to lack of chemical stimulation.





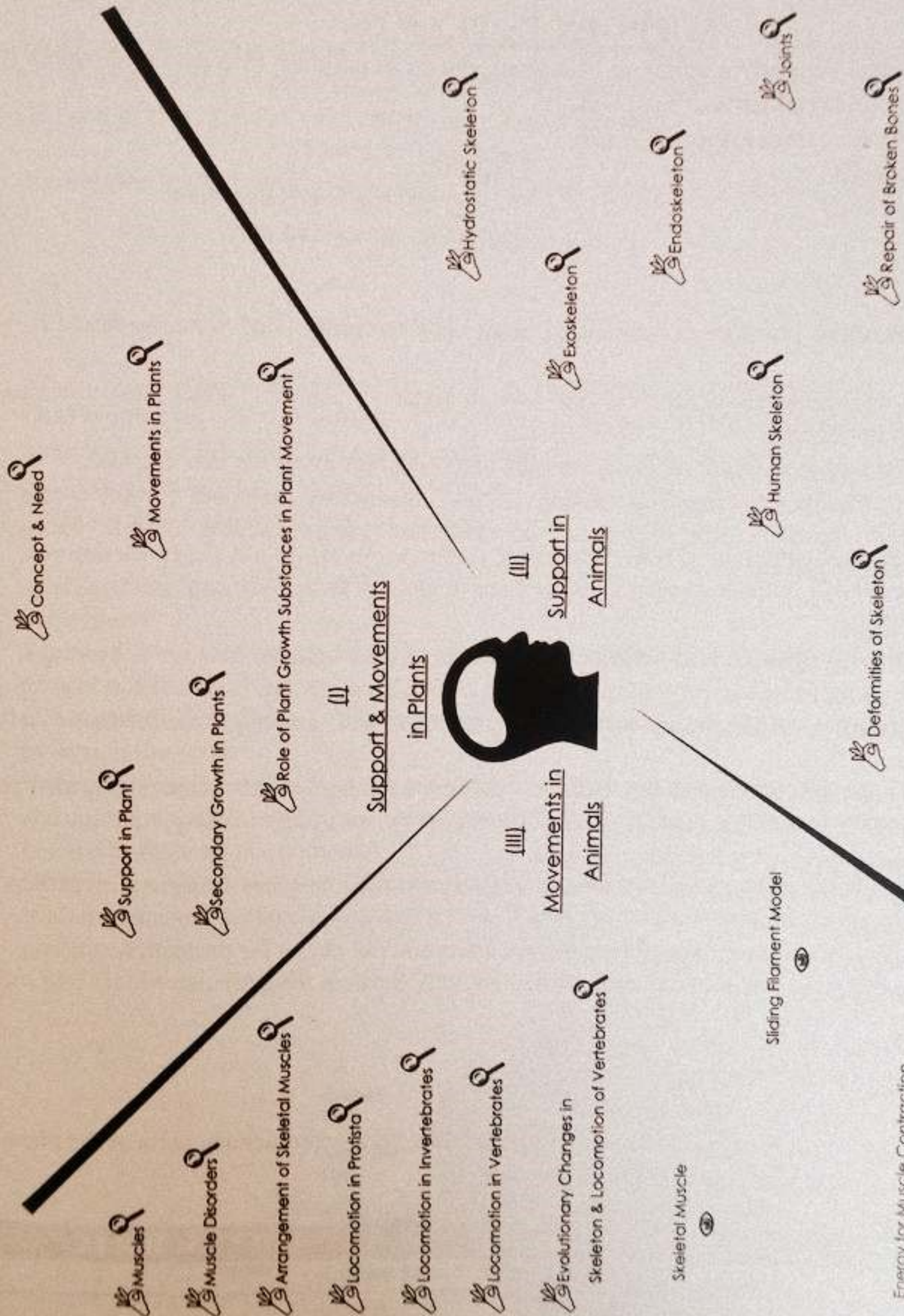
48. Which of the following treatment will be administered first in a newly diagnosed renal failure patient?  
 (a) Renal transplant (b) Peritoneal Dialysis  
 (c) Lithotripsy (d) Hemodialysis
49. Formation of heat shock proteins in plants results in  
 (a) Elevation of temperature in cold conditions.  
 (b) Embracing the enzymes and other proteins and prevent their denaturation.  
 (c) Change the chemical nature of other proteins thus making them heat resistant.  
 (d) Help in evaporative cooling.
50. Which adaptation is acquired by plants of cooler areas to prevent lipid crystal formation in cell membrane?  
 (a) Change in membrane protein composition.  
 (b) Change in the solute composition of the cell membrane which prevents crystallization.  
 (c) Increase in proportion of unsaturated fatty acids.  
 (d) Development of heat shock proteins.
51. Animals that produce metabolic heat at low level and also absorb heat from the surroundings are called  
 (a) Endotherms (b) Ectotherms  
 (c) Heterotherms (d) Homeotherms
52. Fishes, most of the invertebrates and amphibians are examples of \_\_\_\_\_ animals  
 (a) Endotherms (b) Ectotherms  
 (c) Heterotherms (d) Homeotherms
53. Bats & humming birds belong to  
 (a) Endotherms (b) Ectotherms  
 (c) Heterotherms (d) Homeotherms
54. Normal body temperature in mammals like human beings is  
 (a)  $26 - 28^{\circ}\text{C}$  (b)  $36 - 38^{\circ}\text{C}$   
 (c)  $46 - 48^{\circ}\text{C}$  (d)  $56 - 58^{\circ}\text{C}$
55. Brown fat present in certain mammals is specialized in  
 (a) Providing insulation in cold environment. (b) Providing insulation in hot environment  
 (c) Rapid heat production. (d) Controlling heat production.
56. Blubber a thick layer of fat is present in  
 (a) Fresh water mammals. (b) Terrestrial mammals.  
 (c) Marine mammals. (d) Flying mammals.
57. Panting is a representative of which mechanism  
 (a) Pigmentation. (b) Respiration.  
 (c) Evaporative cooling. (d) Excretion.
58. Thermostat of human body is present in  
 (a) Fore brain. (b) Hind Brain.  
 (c) Thalamus. (d) Hypothalamus.
59. Production of pyrogens is a \_\_\_\_\_ phenomenon  
 (a) Protective (b) Destructive  
 (c) Constructive (d) Aggressive
60. Name the type of adaptation from the following that is responsible for shivering thermogenesis  
 (a) Structural (b) Physiological  
 (c) Behavioral (d) None of these





# Chapter 16

## SUPPORT & MOVEMENT







The main difference between plants and animals is in their locomotion, animals show movement while plants do not.

### SUPPORT IN PLANTS

- Stem is the basic supportive structure of a plant, which in addition also acts as a supply line between root and aerial parts of the plant.
- Cells for support in stem responsible are:
  - Collenchyma cells
  - Sclerenchyma cells
  - Living cells of

In cortex.

Heavily lignified cells in xylem.

Epidermis, cortex and pith.

#### **Turgor Pressure**

- Internal hydrostatic pressure developed by plant cells by osmosis of water is called *turgor pressure*.
- Living cells of epidermis, cortex and pith take in water by osmosis, which keep them rigid and resistant to bending.
- Generation of turgor pressure results from high osmotic pressure of the cell vacuole.
- Tonoplast** is membrane bounding vacuole. It contains active transport system consisting pumps, which maintain still high ionic concentration inside vacuole despite of higher extracellular concentration.

#### **Sclerenchyma Cells**

- These are heavily lignified non-living cells in xylem tissue of plants.
- They play important role in providing support to adult plants.
- They consist of thick secondary cell wall impregnated with an inorganic substance called **lignin**.
- Sclerenchyma Cells** play important role in providing support to adult plants. They also play important role in providing support to baby, young herbaceous parts of the plants
- There are three types of sclerenchyma cells:
  - **Fibers (tracheids)** are long or cylindrical, existing as solid bundles in xylem or as bundle caps.
  - **Sclereids** are shorter than fibers, found in seed coats and nut shells for protection.
  - **Vessels (trachea)** are water conducting pipes in xylem, thus are long tubular with joined ends

#### **Collenchyma Cells**

- They are supportive cells present in **cortex**.
- They are grouped in strands or cylinders.
- They play important role in providing support to baby, young herbaceous parts of the plants
- They lack secondary wall but contain protoplast.
- They are elastic thus elongate with the growth of stems and leaves.

FEATURE	SCLERENCHYMA	COLLENCHYMA
Nature of cells	Dead	Living
Secondary cell wall	Thick due to lignin	Absent
Plants	Shrubs & Trees	Young herbaceous plants
Flexibility	Rigid	Flexible
Support	Rigid	Flexible
Location	Cortex	Xylem, seed coat, shell

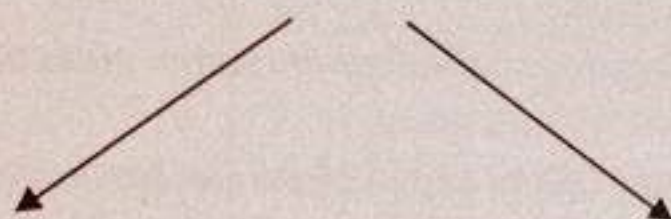


SIGNIFICANCE OF SECONDARY GROWTH

- An increase in plant girth due to activity of vascular cambium is called *secondary growth*.
- It is most evident in woody perennial plants like trees, shrubs and vine.
- Division of two types of cells results in secondary growth.

**Vascular Cambium**

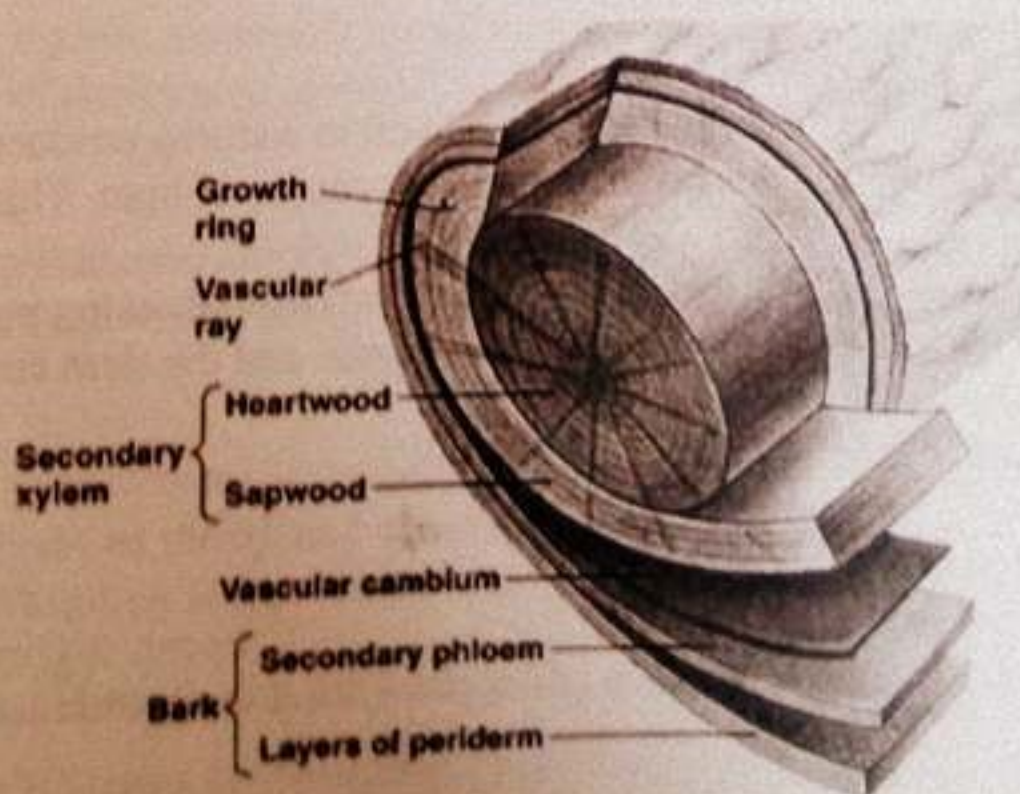
(First appearing as actively dividing cells between primary xylem and primary phloem)

**Secondary Xylem**

- Next to inner surface of vascular cambium.
- Causes most of the increase in stem thickness.
- Only the outer most or the youngest tissue
- Conducts water and dissolved substances.
- **Annular rings** are the layers of secondary xylem resulting from continuous activity of vascular cambium, indicating the age of the tree at the time it was cut. Only one ring is added in each year.
- **Sapwood** is the active portion of the wood that conducts water and dissolved substances. It is present outside the heart wood.
- **Heart wood** is inactive non- conducting portion of wood is called heart wood. It is usually present in the centre.
- Variety of substances may get accumulated in heart wood of number of trees like red cedar and conifers, for example resins, oils, gum and tannins. These provide resistance to decay and protection from an insect attack.
- **Callus** is a newly formed wood tissue, paranchymatous in nature, formed on or over the wound (damaged surface of stem or a root. It also unites the branches during budding or grafting.

**Secondary Phloem**

Appearing outer to vascular cambium.







## PLANT MOVEMENTS

- *Autonomic movements* are spontaneous due to internal causes whereas *paratonic movements* are due to external causes.
- Autonomic movements are of three types i.e. tactic, turgor & growth.
- *Tactic movements* are movements of an entire cells or organism i.e. locomotion due to external stimulus.
- When tactic movement is toward stimulus, called *positive*, and away from stimulus, called *negative*.
- Tactic movement in response to light is called *phototactic movement* e.g. movement of chloroplast due to cyclosis.
- Tactic movement in response to chemicals is called *chemotactic movement* e.g. movement of sperm of liverworts, mosses, ferns towards archegonia.
- *Sleep movements* (e.g. bean plants) and rapid movement of leaflets (e.g. mimosa) is examples of turgor movements.
- In *epinasty*, growth on upper side is more as compared to lower side.
- In *hyponasty*, growth on lower side is more as compared to upper side.
- Zigzag movement of stem due to alternate growth pattern on opposite sides is called *nutantion*.
- Different *types of tropic movements* are phototropism (light), thigmotropism (touch), chemotropism (chemicals), hydrotropism (water) and geotropism (gravity).
- *Nastic movements* are non-directional movements.
- There are two types of nastic movements i.e. nyctinasty and haptinasty.
- *Nyctinasty* are due to turgor and growth changes. It may be of two types i.e. photonasty and thermonasty.
- *Haptonastic* movements are in response to contact.

### ROLE OF GROWTH SUBSTANCES IN PLANT MOVEMENT

Plant movements are controlled by hormones e.g.

#### **Auxins**

- Play important role in tropic movements.
- Unequal distribution of auxin indole acetic acid (IAA) in a stump produces unequal cell enlargement, causing a bend in the organ towards the source of light. This is called phototropism.
- Cells of upper surface elongate if the root curves downwards, showing positive geotropism. On the other hand the cells on the lower surface elongate and the stem curves upward, is an example of negative geotropism.
- Epinasty is controlled by auxins.

#### **Abscisins and Gibberellins**

- Control nastic movements.
- Abscisins are inhibitory hormones, while gibberellins are growth stimulators.





1. \_\_\_\_\_ is the basic supportive structure of a plant, also acts as a supply line between root and aerial parts of the plant.
2. \_\_\_\_\_ is membrane bounding vacuole.
3. \_\_\_\_\_ is the active portion of the wood that conducts water and dissolved substances.
4. \_\_\_\_\_ movements are movements of an entire cells or organism.
5. Zigzag movement of stem due to alternate growth pattern on opposite sides is called \_\_\_\_\_.

### SUPPORT AND MOVEMENT IN ANIMALS

Skeleton (forming bones and joints), along with muscles are responsible for support and locomotion in animals:

#### ANIMAL SKELETON

- Skeleton is a tough and rigid framework, providing protection, shape, and support to the body organ.
- It is composed of organic or inorganic substances or both.

#### **Functions Of Skeletal System**

- Support and shape to the body.
- Attachment to muscles and movement.
- Protection to vital organs like brain, lungs, heart and spinal cord.
- Mineral homeostasis through storing and releasing minerals like  $\text{Ca}^{2+}$ ,  $\text{PO}_4^{3-}$ ,  $\text{Na}^+$  and  $\text{K}^+$ .
- Presence of bone marrow, in which blood cells are synthesized.

There are three types of skeleton in animals:

#### **Hydrostatic Skeleton**

- A fluid filled gastrovascular cavity or coelom, preset in those animals lacking hard skeleton.
- It provides support and resistance to the contraction of muscles, which results in motility.

#### **Examples**

Present in soft body invertebrates like cnidarians and annelids.

- A sea anemone closes its mouth and constricts its muscles fibers that are arranged in circle around the body, resulting in generation of pressure in sea water filled central cavity causing maintenance of upright stature.

(1) Stem (2) Tonoplast (3) Sapwood (4) Tissue (5) Mutation

ANSWERS



- In earthworm, fluid filled compartment separated by septa forms its hydrostatic skeleton.
  - Circular muscle contraction      Elongate the compartment.
  - Longitudinal muscle contraction      Shorten the compartment.(These alternating shortening and lengthening waves move the earthworm).

### Exoskeleton

- A hard covering present on the outer side of the body, supporting and protecting it, and providing a surface for muscle attachment.
- It is inert and non-living.
- It is secreted by ectoderm.
- It is composed of two layers.

### Examples

#### Shells of Molluscs

- It is composed of just one or two pieces.
- Shells of marine snails are hard because of  $\text{CaCO}_3$  while that of land snails are lighter as they lack hard minerals.
- They grow with the animal with growth rings evident on the shell.
- Molluscs also have hydrostatic skeleton in their soft parts.

#### Exoskeleton of Arthropods

It is the most complex one.

- The epicuticle is the outer most layers. It is made up of waxy lipoprotein.
- The bulk of exoskeleton is called procuticle. It is composed of chitin, polysaccharide and several kinds of proteins.

#### Adaptations in Exoskeleton

- Invaginations of exoskeleton form firm **ridges and bars** for muscle attachment.
- Formation of joints, which enhance the movement, since exoskeleton is thin, soft and flexible at joints.
- Presence of sensory receptors in exoskeleton called **sensilla**.
- Modifications in it permit gaseous exchange.

#### Advantages

It protects the arthropods from rough environment and their enemies.

#### Disadvantages

It inhibits the growth of the animal.

#### Moulting or Ecdysis

- Replacement of existing exoskeleton with a new and a bigger skeleton is called ecdysis. This process enables arthropods to grow and enlarge their size.
- This process is controlled by neural & hormonal (ecdysone) interaction.

#### Endoskeleton

- Such a skeletal system which is present inside the body covered by muscles and skin is called endoskeleton.
- It is made of two types of tissues i.e. bones and cartilages.



- Both are rigid connective tissue consisting of living cells embedded in the collagenous matrix.

### Bones

- It is the most rigid connective tissue.
- It consists of *three types* of cells.
  - Osteoblast Bone forming cells.
  - Osteoclast Bone dissolving cells.
  - Osteocytes Mature bone cells.
- Each bone consists of an outer compact bone and an inner spongy one.
- Compact bone** is the outer denser and a stronger portion, which provides an attachment to muscles.
- Spongy bone** is the inner light and the porous bone, rich in blood vessels, in the cavity (bone marrow) of which blood cells are synthesized.

### Cartilage

- It is a softer avascular form of connective tissue.
- It covers the end of the bones at the joints, and forms the flexible parts like nose and ears.
- Chondrocytes are the living cells of cartilage, which secrete flexible, elastic, non-living matrix consisting of collagen.
- There are three main types of cartilage:
  - Hyaline cartilage** is found at the movable joints, and is the most abundant.
  - Fibrocartilage** has collagenous matrix, and forms structures like external pinna of ears and epiglottis.
  - In Elastic cartilage** elastic fibers are prominent in the matrix. They are least abundant in their distribution, e.g., form Auditory (Eustachian) tube.

	EXOSKELETON	ENDOSKELETON
Origin	Secreted by ectodermal cells.	It arises from mesoderm.
Nature	Non-Living	Living
Location	It is present external to skin & muscles	It is present internal to skin & Muscles.
Comments	It restricts movement & growth	It does not restrict body movement as joints are present. Moreover it grows along with body.

### HUMAN SKELETON

MAJOR PART	SUBPARTS	BONES
		<b>Axial Skeleton</b>
Skull	Cranium (8)	<ul style="list-style-type: none"> <li>Paired (2): Parietal &amp; Temporal</li> <li>Unpaired (4): Frontal, Occipital, Sphenoid, Ethmoid.</li> </ul>
	Face (14)	<ul style="list-style-type: none"> <li>Paired (6): Maxilla, Zygomatic, Nasal, Lacrimal, Palatine, Inferior Concha.</li> <li>Unpaired (2): Mandible, Vomer</li> </ul>





## Chapter 16

## Support &amp; Movement

Vertebral Column (33 vertebrae)	Cervical	7 vertebrae, neck region, first two atlas and axis
	Thoracic	12 vertebrae
	Lumbar	5 vertebrae
	Pelvic	9 vertebrae, anterior 5 join to form sacrum & posterior 4 join to form coccyx
Rib cage and sternum	12 pairs of ribs	<ul style="list-style-type: none"> <li>12 pairs articulate with thoracic vertebrae posteriorly.</li> <li>Ten pairs connect anteriorly with sternum either directly or through costal cartilages &amp; 2 pairs are of floating ribs (since they don't attach to the sternum).</li> </ul>
Appendicular Skeleton		
Pectoral Girdle	Scapula, suprascapula & clavicle (connects scapula with sternum).	
Fore limb	1 humerus, 1 radius & 1 ulna, 8 carpals, 5 metacarpals & 14 phalanges	
Pelvic Girdle	2 coxal (hip) bones. Each having ilium, ischium & pubis.	
Hind limb	1 femur, 1 tibia & 1 fibula, 8 tarsals, 5 metatarsals & 14 phalanges.	

- Pectoral girdle attaches upper limb with the vertebral column.
- Pelvic girdle attaches lower limb with the vertebral column.

JOINTS

- When two or more bones or cartilages come in contact with each other an articulation or joint is formed.
- They hold the skeleton together and allow mobility.
- Study of joints is called *Arthrology*.

**Classification**

- On the basis of amount of movement allowed joints are classified as:
  - Immovable joints.
  - Slightly movable joints.
  - Freely movable joints. (hinge and ball and socket joints).
- On the basis of structure joints are classified as:

FEATURES	FIBROUS JOINTS	CARTILAGINOUS JOINTS	SYNOVIAL JOINTS
STRUCTURE	They are held together by short fibers embedded in connective tissue. Union is due to	In these joints bones are united by a cartilage.	Consisting of a joint cavity filled with synovial fluid, lined by synovial membrane and





	dense fibrous tissue.		surrounded by fibrous capsule.
MOVEMENT	Fixed & No movement	Little or no movement	Maximum mobility
DISTRIBUTION	Joints between skull bones	Present in those sites where stability and strength is required than free movement.	Where great degree of mobility is required e.g., shoulder joint and hip joint

- *Cartilaginous joints with hyaline cartilage* are present in between long bones.
- *Cartilaginous joints with fibrous cartilage* are e.g., pubic symphysis (a joint present anteriorly in between two hip bones)
- Synovial joints based on structure and movements allowed are classified further into:

FEATURE	HINGE JOINTS	BALL & SOCKET JOINTS
STRUCTURE	Are like hinges of door	Consisting of a globular head fixed in a cup shaped concavity
MOVEMENT	Only to and fro movement is allowed.	Polyaxial, in multiple planes
FLEXIBILITY	Limited than ball and socket	Maximum flexibility
MUSCLE ARRANGEMENT	Pair of muscles are arranged in the same plane as that of joint. Origin of muscle on one side of joint, while insertion on the other	At least two pairs of muscles present perpendicular to each other.
EXAMPLES	Joints of elbow and knee	Hip joint and shoulder joint.

### SKELETAL DEFORMITIES

Causes of skeletal deformities are as follows:

#### GENETIC CAUSE

Skeletal deformities may be congenital in presentation like:

##### **Cleft Palate**

With a persistent opening in between oral and nasal cavity results in disturbance while sucking and inhalation of food in respiratory tract causing aspiration pneumonia.

##### **Microcephaly**

Individuals with small sized skull.



**Arthritis**

- Inflammatory or degenerative disease damaging joints. Membrane lining the joint thickens; fluid protection is lost, resulting in loss of friction.
- *Arthritis* means inflammation of joints.
- *Acute form* caused by bacterial invasion, and treated with antibiotics.
- *Chronic* are mostly genetic in origin including osteoarthritis, rheumatoid arthritis and gouty arthritis.
- *Osteoarthritis* is a disease of synovial joints, characterized by cartilage loss. Genes responsible for synthesis of collagen type II are defected.
- *Rheumatoid arthritis* is symmetrical poly arthritis of unexplained cause.

**HORMONAL CAUSE****Osteoporosis**

- Group of diseases in which bone resorption out paces bone formation.
- It results from *estrogen deficiency*, which is necessary for normal mineralization of bones.
- It is more common in *old women*. Other causes include insufficient exercise, diet deficient of  $\text{Ca}^{2+}$  and  $\text{PO}_4$  and smoking.
- Protection and treatment estrogen replacement therapy.

**NUTRITIONAL CAUSES****Osteomalacia**

- $\text{Ca}^{2+}$  deficiency in adults results in defective mineralization of bone causing it to be weakened and soften.
- Primarily weight bearing bones of leg and pelvis are deformed and get bowed causing pain when receive weight.

**Rickets**

- $\text{Ca}^{2+}$  and Vit D deficiency in children causes bowed legs and deformed pelvis.
- Treated with Vit D fortified milk and sunlight exposure to enhance vit D activation.

**Disc Prolapse**

- Sudden physical trauma like bending forward while lifting a heavy weight results in herniation of disc.
- Protrusion of nucleus pulposus. May result in compression of spinal cord or any nerve root.
- Disc prolapse is treated with bed rest, traction and analgesics as a pain killer. If fails, the disc is removed surgically.

**Spondylosis**

- It is a form of arthritis in which there is immobility and fusion of vertebral joints.
- A spondylotic vertebrae is called Bamboo spine, since it is same as an elongated upright bamboo stem.

**Sciatica**

It is a stabbing pain radiating along the course of sciatic nerve in the leg.

**Causes**

- Fall, herniated disc, improper buttock injection.





- If just compressed result in excruciating pain in the leg, but if transected leads to complete
- Paralysis of that leg.
- Recovery is usually slow and incomplete

### FRACTURE & ITS REPAIR

#### **Fracture**

Break in the continuity of a bone is called a fracture.

#### **Treatment**

Fracture repair comprises of reduction, fixation in realigned position and immobilization

#### **Reduction**

Fractured segments are returned to their original position.

- **Closed:** Bone ends are returned back at their normal position manually.
- **Open:** Surgery is performed to return the broken ends to their original position.

#### **Fixation**

Reduced segments are fixed both by open and closed techniques.

#### **Immobilization**

Immobilization of fractured bone is done via a cast or by traction. It is necessary for proper healing.

### **THE PROCESS OF HEALING AND REPAIR**

Ideal healing time is 8 – 12 weeks, but is longer in the presence of infection, poor health and diet, in weight bearing bones, and in bone with poor blood supply ( e.g., of an elderly individual). There are four phases of repair.

#### **Hematoma Formation**

- A mass of a clotted blood at the fracture site.
- Comes from torn blood vessels of the bone and in its surrounding.
- Contains substances like Bone Morphogenic proteins( BMP), which help in healing process.

#### **Soft Callus Formation**

- It is formed within 3- 4 weeks
- Capillaries grow in hematoma and remove debris.
- Fibroblast and osteoblast migrate and construct a bone called soft callus.

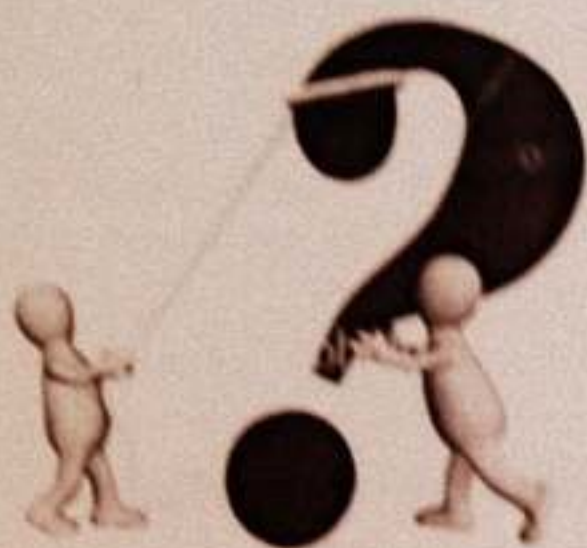
#### **Bony Callus**

- By osteoblast and osteoclast cells.
- Begin 3- 4 weeks after injury, upto firm bone formation i.e., within 2- 3 months.

#### **Remodeling**

- By osteoclast cells.
- Excess bony callus on the outside is removed.





1. \_\_\_\_\_ is a tough and rigid framework, providing protection, shape, and support to the body organ.
2. In earthworm, fluid filled compartment separated by septa forms its \_\_\_\_\_ skeleton.
3. \_\_\_\_\_ bone is the outer denser and a stronger portion, which provides an attachment to muscles.
4. Group of diseases in which bone resorption outpaces bone formation is \_\_\_\_\_.
5. Ideal healing time is \_\_\_\_\_ weeks.
6. \_\_\_\_\_ is a stabbing pain radiating along the course of sciatic nerve in the leg.
7. \_\_\_\_\_ joints allow movements in all possible directions.

### MUSCLES

Vertebrates have three types of muscles: Smooth, Cardiac and skeletal muscles.

PROPERTY	SMOOTH	CARDIAC	SKELETAL
Muscle appearance	Unstriated (non striated)	Irregular stripes (striated)	Regular stripes (striated)
Cell shape	Spindle	Chain of cells organized in to branched and interconnected fibers	Cylindrical
Number of nuclei	One per cell	Many per cell.	Many per cell
Speed of contraction	Slow	Intermediate	Slow to rapid
Contraction caused by	Spontaneous, stretch, nervous system, hormones	Spontaneous	Neuronal signals.
Function	Controls movement of substances through hollow organs	Pumps blood	Moves the skeleton
Control	Autonomic (involuntary)	Involuntary	Voluntary
Location.	Blood vessels, GIT, other hollow organs.	Heart.	Attached to skeleton via tendons (non-elastic collagenous fibers), and thus associated with the movement of bones

ANSWERS: (1) Skeleton (2) Hydrostatic (3) Compact (4) Osteoporosis (5) 8-12 (6) Sciatica (7) Ball & socket





### STRUCTURE OF SKELETAL MUSCLE

- Skeletal muscles → Muscle bundles → Muscle fibers → Myofibrils → Sarcomere (smallest contractile unit of muscle fiber) → Myofilaments (Actin & Myosin)
- **Shape:** long cylindrical.
- **Size:** 10 – 100  $\mu\text{m}$  in diameter.
- **Sarcolemma:** is the surrounding membrane of muscle fiber.
- **Sarcoplasm:** is the fluid part of the muscle fiber, is just like cytoplasm except contain large amount of glycogen and  $\text{O}_2$  bonding protein called myoglobin that stores  $\text{O}_2$
- **Nuclei:** multinucleated.
- **Myofibrills:** Bundles of 1- 2  $\mu\text{m}$  in diameter, running in parallel fashion up to the entire length of muscle fiber, enclosed by its membrane the sarcolemma.
- **Sarcomere:** present in myofibrils and is the smallest contractile unit of muscle fiber. This is the area between two successive Z- lines.
- **A - Band:** A (Anisotropic or polarizing) band is the dark band of sarcomere. Here both actin and myosin are present.
- **I- Band:** I (isotropic or polarizing) band is the light one. Here only actin are present. These alternating light and dark bands give the cell striated appearance.
- **H- Zone:** A lighter zone in the mid of A band.( H= Hele meaning bright).
- **M- Line:** A darker line in the centre of H- zone.
- **Z- Line:** A line in the centre of I- Band. (Z= Zwishen means Between). From here actin filaments arise.
- **Motor Unit:** All the muscle fibers innervated by a single motor neuron, which contracts simultaneously in response to the action potential fired by the motor neuron.
- **Transverse (T) Tubules & T System:**
  - Hollow elongated tubes penetrating the cell,
  - Formed by invagination of sarcolemma.
  - Continuous with extracellular fluid.
  - Are also related with sarcoplasmic reticulum to form a triad.
  - All the T- tubules of each muscle cell are collectively called **T- System**.
  - It extends and encircles the myofibril at the level of Z- line or A- I Junction.

#### Ultra Structure of Myofilaments

##### Myosin

- These are **thick filaments**, extending through the entire length of A- band.
- Diameter is 16 nm.
- Each myosin molecule consists of a tail and two head. Tail consists of two long polypeptide chains coiled together. Heads are globular in shape, also called cross bridges, since they link thick and thin filaments during contraction

##### Actin

- These thin filaments extend across the I- band and partly into A -band.
- Thin filaments are 7- 8 nm thick.
- Each actin molecule consists of two chains which twist around each other like twisted double strands of pearls.
- Two more proteins are present in relation to these thin filaments:



**Tropomyosin**

- It is present in the grooves of double helix structure of actin molecules during resting condition.
- It covers those active sites on actin molecules which are meant to interact with myosin molecule during muscle contraction.

**Troponin**

It is composed of three polypeptide complex, one binds to actin, another binds to tropomyosin, while third binds to  $\text{Ca}^{2+}$  ions.

**SLIDING FILAMENT MODEL**

- H. Huxely and A.F. Huxely suggested this model of muscle contraction.
- Cross bridges of thick filaments become attached to the binding site on the actin filaments. This pulls the actin filament towards the centre of the sarcomere.
- All these events result in shortening of I- band, approximation of Z- line and disappearance of H- zone.
- During all these processes, the length of thick and thin filament will remain unchanged.

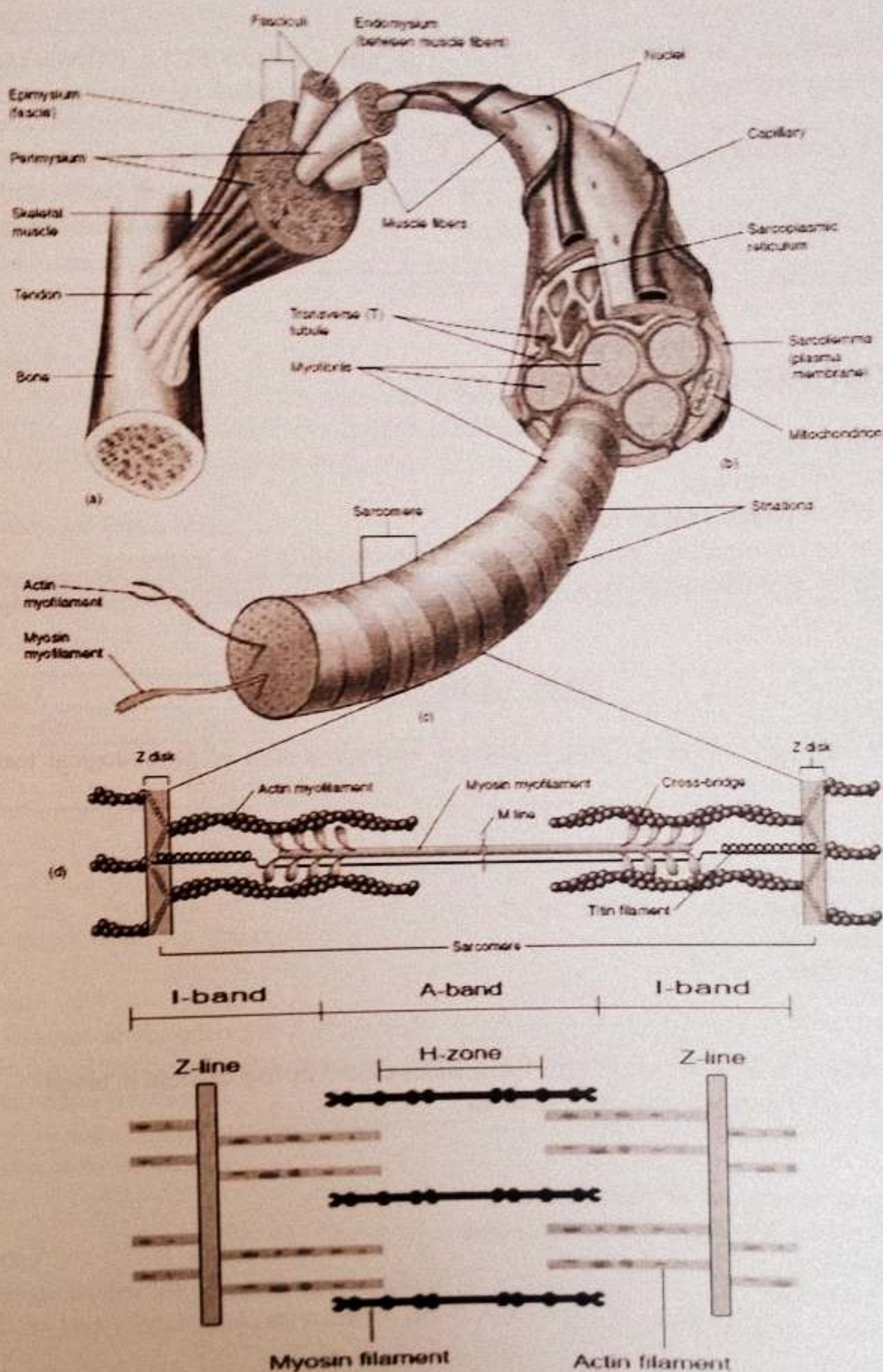
**The Mechanism**

- Muscle contraction is initiated by nerve impulse arriving at neuromuscular junction, which is carried through T- tubules to sarcoplasmic reticulum, cause them to release  $\text{Ca}^{2+}$  in sarcoplasm.
- $\text{Ca}^{2+}$  binds to troponin, this results in uncovering of Actin binding sites by tropomyosin.
- Myosin cross bridges attach to actin binding sites, which result in their overlapping and contraction occur.
- I band → Shorten.
- Z- line → get closer.
- H- zone → disappear.

**All or None Response**

- All the fibrils of a muscle fiber will contract collectively in a particular contraction. However the degree of contraction depends upon the number of participating fibers.
- **Rigor Mortis** is stiffening of the body after death. Since ATP is required to break the bond between actin and myosin, which get deficient after death, thus the bridges can't be broken and the body gets stiff.







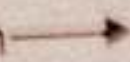
## Energy For The Muscle Contraction

## UNDER NORMAL CONDITIONS

Stored glycogen in the cell



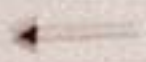
glucose → Aerobic breakdown



ATP

UNDER STRESS FULL CONDITIONS  
(high metabolic activity e.g., exercise)

- 1) Creatine phosphate
- 2) Glucose → Lactic acid  
(anaerobic breakdown)



- Lactic acid → 1/5 broken aerobically  
4/5 → Glucose

## EFFECT OF EXERCISE ON MUSCLES

- Increase in size of the muscle.
- Increase in its strength.
- More efficient and fatigue resistant.
- Capillaries surrounding muscle fibers and mitochondria in it increases.
- Synthesize more myoglobin

MUSCLE DISORDERS**Muscle Fatigue**

Lactic acid accumulation causes *muscle fatigue*, which is a state of physiological inability to contract.

**Caused by:**

- Relative deficiency of ATP.
- Accumulation of lactic acid → ↓ the pH  
→ muscle ache.
- Ionic imbalance.

**Tetany**

- It is condition of muscle twitches and convulsions caused by low calcium in blood.
- May be fatal if involves respiratory muscles.

**Cramp**

- It is tetanic contraction of entire muscle.
- It can last from few seconds to several hours.
- It is caused by:
  - Low blood sugar.
  - Electrolyte depletion
  - Dehydration
  - Irritability of spinal cord and neurons.
- Muscles become taut and painful, most common in thigh and hip muscles, usually in night and after exercise.





### ARRANGEMENT OF SKELETAL MUSCLES FOR MOVEMENT OF SKELETON

- **Origin** is attachment of muscle on fixed bone and thus remains fixed when muscle contracts.
- Attachment of muscle on movable bone is called **insertion**, which thus moves the bone.
- **Belly** is the thick part between origin and insertion which contracts.
- **Ligaments** are type of a connective tissue that **attach** bone to a bone and are slightly elastic.
- **Tendon** is an example of a connective tissue that anchor the muscle to bone and are non-elastic.

#### **Antagonistics**

- Pair of muscle in which one member contracts while other relaxes, so reverse the effect of each other and do not contract simultaneously is called antagonism.
- There are **650 muscle in human body**, most of which are in antagonistic arrangement.

#### **Muscles Around Elbow Joint**

MUSCLE	ORIGIN	INSERTION	FUNCTION
Biceps	By two heads from scapula	Medial surface of radius	Lifts radius (flexion)
Brachialis	Humerus	Ulna	Lifts ulna (flexion)
Brachioradialis	Humerus	Radius	Lifts radius (flexion)
Triceps	By three heads from scapula & humerus	Olecranon process of ulna	Straightens elbow (extension)

### LOCOMOTION IN EUGLENA

*Euglena* moves with help of **flagellum**.

#### **Flagellum**

- It is attached to the anterior end of the body
- When wiped backward organism moves forward, while when it wipes forward the organism doesn't move backwards
- Waves of activity pass in spiral fashion from its base to its tip; this causes the body to rotate forward about its axis.

#### **Myonemes**

- These are contractile structure running along the length of its body
- With the help of these *euglena* is able to change the shape and its direction

#### **Euglenoid Movement**

It is change in the shape and direction of the body by contraction of myonemes resulting in shortening and widening first at the anterior end then in the middle and later at the posterior end.





### MOVEMENT IN PARAMECIUM

*Paramecium* moves with help of *cilia*.

#### CILIA

- These are fine thread like extension of cell membrane.
- They range in length few microns – many 100  $\mu$  from 0.1-0.5  $\mu$  in diameter.
- Don't move simultaneously, a bunch moves in a progressive wave like fashion, starting at the anterior end and progresses backwards.

#### Ultrastructure

- Each cilium consists of nine peripheral double fibrils and two central smaller one.
- All run longitudinally through the cilium.
- They are covered by extension of cell membrane.

#### Mechanism

Exact unknown is unknown. *Bradford* suggested the movement of cilia.

According to it;

- Five out of nine (5/9) double fibrils contract or slide simultaneously and cilium bends or shortens. It is called *effective stroke*.
- Four out of nine (4/9) fibrils contract and cilium becomes straight. It is called *recovery stroke*.
- Alternate bending and recovery results in locomotion.
- Energy for this process comes from ATP.

### MODES OF LOCOMOTION IN ANIMALS

ANIMAL	MODE OF LOCOMOTION	STRUCTURES INVOLVED
Euglena	Flagellary (euglenoid) locomotion	Flagellum, Myonemes
Paramecium	Ciliary locomotion	Cilia
Amoeba	Amoeboid movement	Pseudopods: finger like projection of cytoplasm.
Jelly fish	Jet propulsion: forcing the water out of bell, on it contraction causing the animal to move.	Body muscles, tentacles
Earthworm	Accordion-like movement	Setae & muscles( alternating contraction and lengthening of longitudinal and circular muscles)
Cockroach	Swift walking & flight	Legs ( 3 at a time) & wings ( posterior pair out of 2).
Snail	Crawling	Muscular foot
Star fish	Gliding	Tube feet
Fish	Swimming	Tail & fins
Amphibians	Walking & hoping	4 limbs
Reptiles	Walking, running, creeping	Legs
Birds	Flight (passive or active)	Wings
Mammals	Walking & running	Legs





### SWIMMING IN FISH

#### Adaptations for Swimming

##### Streamlined Body

- Tapered at both the ends with only fins projecting from the body. It results in reduction of dragging.
- Exudates from mucus and oil glands reduce the friction between water and the fish by keeping the dermal denticles in cartilaginous fish and scales in bony fish moist.

##### Fins

- Unpaired dorsal and ventral: stabilize the fish fins
- Paired pectoral and pelvic fins act as steering and balancing structure of the body
- Tail fins cause forward movement of fish.

##### Buoyancy

By swim bladder.

##### S- Band Locomotion

Alternating contraction of muscles of both the sides: e.g., in cartilaginous fish like dog fish. This results in characteristic S- band locomotion.

### LOCOMOTION IN AMPHIBIANS

- The general build of body is essentially fish-like body.
- They swim on land i.e. drag their body.
- Few raise their body up on legs.
- In anurans, the entire skeleton and muscular system has become specialized for peculiar swimming and jumping methods of locomotion, by mean of extensor thrust of both hind limbs.
- Frogs and toads also walk and hop on land due to their strong hind limbs.

### ADAPTATIONS IN REPTILES FOR LOCOMOTION

##### Skeleton

Their skeleton is highly ossified.

##### Cervical Vertebrae

First two provide greater freedom for movement.

##### Axis

It is modified for rotational movement.

##### Ribs

They may have muscular connections to the large belly scales to aid locomotion.



**Bipedal**

In prehistoric reptiles, having narrow pelvis and heavy outstretched tail for balance. Presence of free front appendage for prey capture or flight.

### ADAPTATIONS FOR AERIAL MODE OF LOCOMOTION IN AVES

**Skeleton**

- Light skeleton with large air spaces reduce their weight.
- Number of the bones is less than other vertebrates.
- Bones may fuse together for strength.
- Enlargement of pectoral girdle and a sternum acting as a keel for muscle attachment.
- Tendon of supra-coracoid muscle passes through an opening, the foramen triosseum formed between scapula, coracoid and clavicle bones.

**Feathers**

They give wings a large surface area to keep the birds in air.

**Energy for Flight**

Feathers keep their body warm, thus can produce enough energy.

**Wings**

They are evolved form of forelimbs. Pectoral muscles pull the wings up and down.

**Shape of wings**

- Long narrow wings are ideal for gliding through wind, e.g., in gulls and other sea birds. This is called passive flight.
- Short broad wings like those of most garden birds are most effective for slow flapping flight. This is called active flight.

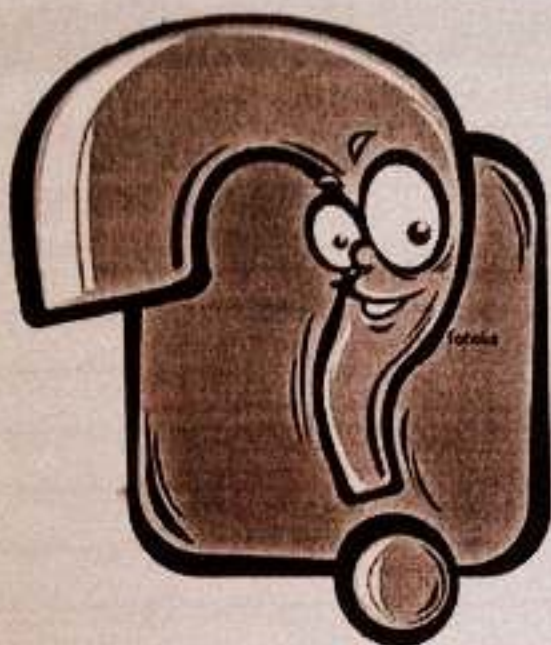
**Streamlined body**

It decreases the air resistance.

### LOCOMOTION IN MAMMALS

- Mammals which walk on their sole are called *plantigrade* e.g. monkey, man, apes, bear etc.
- Mammals which walk on their digits only is called *digitigrade* e.g. rabbit, rodent etc. They walk faster than plantigrade.
- Mammals which walk on the tips often modified into hoof are called *unguligrade* e.g. deer, goat etc. It is the swiftest type of the locomotion.





1. \_\_\_\_\_ is the surrounding membrane of muscle fiber.
2. Diameter of thick filament is \_\_\_\_\_.
3. \_\_\_\_\_ is condition of muscle twitches and convulsions caused by low calcium in blood.
4. \_\_\_\_\_ is the thick part between origin and insertion which contracts.
5. There are \_\_\_\_\_ muscle in human body, most of which are in antagonistic arrangement.
6. Each cilium consists of \_\_\_\_\_ peripheral double fibrils.
7. Mode of locomotion in prehistoric reptiles was \_\_\_\_\_.
8. \_\_\_\_\_ is the swiftest type of the locomotion in mammals.

Answers: (1) Sarcolemma (2) 16 nm (3) Tetany (4) Belly (5) 650 (6) 9 (7) Bipedal (8) Unguligrade



## VALUES

Property	Value
Number of bones in cranium of man	8, 4 unpaired & 4 paired
Number of facial bones in man	14, 2 unpaired & 6 paired
Total number of vertebrae in man	33
Cervical vertebrae	7
Thoracic vertebrae	12
Lumbar vertebrae	5
Pelvic vertebrae	9
Sacrum	Anterior 5 vertebrae
Coccyx	Posterior 4 vertebrae
Ribs	12 pairs
Floating ribs	2 pairs
Carpal (wrist bones)	8
Metacarpals	5
Tarsals	8
Metatarsals	5
Phalanges	14
Healing time for broken bones	8-12 weeks
Formation of soft callus within	3-4 weeks
Formation of firm bony union	2-3 months
Diameter of muscle fiber	10-100 $\mu\text{m}$
Diameter of myofibril	1-2 $\mu\text{m}$
Diameter of thick filament	16 nm
Diameter of thin filament	7-8 nm
Amount of lactic acid broken aerobically at rest after fatigue	1/5
Lactic acid into glucose	4/5
Mortality rate in developing countries due to tetanus	40%
Muscles in human body	650
Length of cilia	Many microns to many hundred microns





## PRACTICE EXERCISE



- Which of the following plays the major role in providing support to young herbaceous parts of the plant:
  - Living cells of epidermis with higher turgor pressure.
  - Living cells of cortex and pith with higher turgor pressure.
  - Collenchyma cells
  - All of these
- Higher turgor pressure in a plant cell is maintained by:
  - Large number of vacuoles in a plant cell.
  - Higher ionic concentration inside vacuoles resulting from active pumping of ions at their tonoplastic membrane.
  - Higher osmotic pressure of the cell vacuole.
  - Both b and c
- Secondary cell wall of sclerenchyma cells is impregnated with
  - Cellulose.
  - Peptidoglycan and murein.
  - Lignin.
  - Pectin.
- Among the followings which is the most longest supportive cell?
  - Tracheids.
  - Sclereids.
  - Trachea.
  - Collenchyma cells
- An increase in plant girth due to activity of \_\_\_\_\_ is called secondary growth.
  - Cork cambium
  - Pith.
  - Vascular cambium.
  - Both a and c
- Vascular Cambium initially appears as actively dividing cells between:
  - Primary Xylem and secondary xylem.
  - Primary xylem and secondary phloem.
  - Primary xylem and primary phloem
  - Secondary xylem and secondary phloem.
- Sperms of liverworts, mosses, ferns move towards archegonia, in response to nucleic acid released by the ovum. This is an example of:
  - Chemotropic movement
  - Chemotactic movement.
  - Chemonastic movement
  - Haptonastic movement.
- The place of attachment of leaf with the shoot is called:
  - Pith.
  - Pit.
  - Pulvinus.
  - Ecdysone.
- Rapid movement of leaves of mimosa on touching is an example of :
  - Turgor movement
  - Nastic movement
  - Tropic movements.
  - Growth movement
- Roots of a plant show
  - Positive phototropism and negative geotropism.
  - Negative phototropism and positive geotropism.
  - Negative tactic movement and positive tropic movement.
  - Positive geotropism of stem and roots



11. **Epinasty is controlled by**  
(a) Gibberellins  
(c) Auxins  
(b) Abscissins  
(d) Cytokinins
12. **Gibberellins is an example of**  
(a) Growth inhibitor  
(c) Growth hormone  
(b) Growth stimulator  
(d) None of these.
13. **Which of the following animal has a hydrostatic skeleton:**  
(a) Earthworm.  
(c) Tape worm.  
(b) Round worm.  
(d) Pin worm
14. **In an annelids, the contraction of circular muscle results in:**  
(a) Lengthening of the body.  
(c) Widening of body  
(b) Shortening of the body.  
(d) Thinning of body
15. **Which of the following statement is incorrect about Molluscs?**  
(a) They are surrounded by single or double pieces of hard skeleton.  
(b) Their shell grows as the animal grows.  
(c) They have hydrostatic skeleton.  
(d) They move by tube feet
16. **Which one of the following forms the bulk of exoskeleton of an arthropod?**  
(a) Epicuticle.  
(c) Ectocuticle.  
(b) Procuticle.  
(d) None of these
17. **Exoskeleton of a marine snail is composed of**  
(a)  $\text{CaPO}_4$   
(c)  $\text{CaSO}_4$   
(b)  $\text{CaCO}_3$   
(d)  $\text{SiO}_2$
18. **Which of the following statement about an arthropod exoskeleton is incorrect?**  
(a) It permits gaseous exchange.  
(b) It contains joints, for the same purpose as present in human skeletal system.  
(c) It provides muscle attachment.  
(d) Like all the other types of exoskeleton, they lack sensation.
19. **Ecdysone is**  
(a) An enzyme that digest endocuticle during an arthropodal ecdysis.  
(b) A newly formed exoskeleton in arthropods  
(c) A hormone that regulates moulting in arthropods.  
(d) A process that involves moulting.
20. **Endoskeleton is secreted by:**  
(a) Ectoderm.  
(c) Mesoderm.  
(b) Endoderm.  
(d) All of these
21. **Collagen fibers of bone are hardened by deposition of:**  
(a)  $\text{Ca}$  &  $\text{PO}_4$   
(c)  $\text{CaSO}_4$   
(b)  $\text{CaCO}_3$   
(d)  $\text{SiO}_2$
22. **Which one of the following is avascular structure?**  
(a) A compact bone.  
(c) Cartilage  
(b) A spongy bone.  
(d) All of these
23. **Which of the following bone is not present in the hind-limb?**  
(a) Femur  
(c) Radius  
(b) Tibia  
(d) Fibula
24. **How many bones are present in the wrist?**  
(a) 4 bones  
(c) 8 bones  
(b) 6 bones  
(d) 14 bones





25. Which of the following bones are present in the palm of hand?  
 (a) Carpals (b) Metacarpals  
 (c) Phalanges (d) Metatarsals
26. How many vertebrae are present in vertebral column of man?  
 (a) 33 vertebrae (b) 33 pairs of vertebrae  
 (c) 25 vertebrae (d) 31 vertebrae
27. How many vertebrae are present in coccyx?  
 (a) 7 (b) 12  
 (c) 9 (d) 4
28. How many vertebrae are present in the neck or cervical region of man?  
 (a) 7 (b) 12  
 (c) 5 (d) 4
29. How many vertebrae are present in thoracic region?  
 (a) 7 (b) 12  
 (c) 5 (d) 4
30. How many vertebrae are in sacrum?  
 (a) 7 (b) 12  
 (c) 5 (d) 4
31. How many vertebrae are present in lumbar region?  
 (a) 7 (b) 12  
 (c) 5 (d) 4
32. Which of the following bones are present in pectoral girdle?  
 (a) Clavicle (b) Scapula  
 (c) Both of these (d) None of these
33. A joint formed between humerus, radius and ulna is an example of  
 (a) Immovable joint. (b) Slightly movable joint.  
 (c) Freely movable joint. (d) Fibrous joint
34. Joint between two parietal bones, which is infact immovable one is an example of  
 (a) Fibrous joints. (b) Cartilaginous joints.  
 (c) Synovial joints. (d) None of these.
35. Fibrous capsule surrounding synovial joints may be thickened at some places to form:  
 (a) Synovial membrane. (b) Ligaments.  
 (c) Muscles. (d) Tendon
36. In which of the following joint muscles are arranged in the same plane as that of joint?  
 (a) Between radius and ulna. (b) Between ulna and scapula  
 (c) Between humerus and scapula (d) Between femur and tibia.
37. Which of the following hormone is predominantly responsible for bone weakening in older women?  
 (a) Progesterone. (b) Oestrogen.  
 (c) Parathyroid hormone. (d) Calcitonin.
38. Which of the following is a childhood disease resulting from nutritive  $\text{Ca}^{2+}$  deficiency:  
 (a) Hypocalcaemia Tatanic spasms. (b) Osteomalacis.  
 (c) Rickets. (d) Tetany
39. Which of the following statement about osteoporosis is incorrect?  
 (a) It results from estrogen deficiency.  
 (b) Bone eating process takes over bone formation process.  
 (c) There is reduction of bone mass and change in chemical composition of the matrix.  
 (d) It is common in old age.



40. Which of the following statements about fractures in old age is incorrect?
- They are more common than in adult age.
  - Occur as a result of bone being thin and weak.
  - Due to good blood supply it results in quick healing.
  - It involves osteoblasts and osteocytes.
41. If two ends of fractured bone are opened and kept united via screws and wires drilled in bone substance. This step in fracture repair is called
- Open reduction.
  - Closed Fixation.
  - Open fixation.
  - Immobilization
42. A fracture hematoma has
- Healing properties.
  - Destructive properties.
  - Neutralizing properties.
  - Dead cells
43. Which of the following cells are involved in soft callus formation?
- Fibroblast and osteoblast.
  - Osteoblast and osteoclast.
  - Osteoclast and osteocyte
  - Osteocyte and osteoblast
44. Bony callus formation completes in:
- 2-3 weeks.
  - 3-4 weeks.
  - 2-3 months.
  - 3-4 months.
45. Which of the following is a uni-nucleated cell?
- A smooth muscle cell.
  - A cardiac muscle cell.
  - A skeletal muscle cell.
  - All of these
46. The contraction of which of the following muscle fibers, is controlled by hormones:
- A smooth muscle
  - A cardiac muscle
  - A skeletal muscle.
  - All of these
47. Why skeletal muscles are called striated muscles?
- They appear darker than smooth muscles by naked eye.
  - Alternating dark and light bands appear on their surface when visualized by naked eye.
  - Alternating dark and light bands appear on their surface when visualized via a microscope.
  - All of these.
48. Which of the following statements is incorrect about skeletal muscle fibers?
- They are multinucleated.
  - They are 10 – 100  $\mu\text{m}$  in diameter & surrounded by sarcolemma
  - They contain  $\text{O}_2$  storing molecules called hemoglobin.
  - Their cytoplasm contains high concentration of carbohydrates
49. A smallest contractile unit of muscle contraction called sarcomere is the area between two:
- H- zone
  - M- Line
  - Z- Line
  - A band
50. Diameter of thick filament is:
- 7 nm.
  - 8 nm
  - 16nm
  - 10- 100  $\mu\text{m}$ .
51. The most important function of troponin is
- To bind with actin
  - To bind with tropomyosin.
  - To bind with  $\text{Ca}^{2+}$  ions.
  - All of these
52. If a cross section of a sarcomere is seen, each myosin is surrounded by how many actin molecules:
- 9
  - 5
  - 6
  - 7



53. What happens during muscle contraction to the length of each myosin and actin filament?
- (a) Z- lines get closer  
(b) A band becomes short  
(c) I band elongates  
(d) There is no change in sarcomere
54. Which of the following step occurs immediately after binding of  $\text{Ca}^{2+}$  with troponin molecule during muscle contraction.
- (a) Binding sites of actin get attached to the myosin head.  
(b) Troponin uncovers the actin binding sites.  
(c) Tropomyosin gets removed from the binding sites of actin filaments.  
(d)  $\text{Ca}^{2+}$  goes back inside sarcoplasmic reticulum.
55. Rigor mortis i.e, stiffening of body after death results from:
- (a) Accumulation of rigid proteins molecules in sarcoplasm.  
(b) Unavailability of ATP, which is necessary to break the link between actin and myosin.  
(c) Decrease in body temperature after death.  
(d) Death of tissue due to unavailability of  $\text{O}_2$ .
56. Which of the following statement about fatigue is correct?
- (a) The major event in it is accumulation of lactic acid.  
(b) Lactic acid accumulation turns pH in acidic range leading to muscle ache.  
(c) Ionic imbalance may also cause it.  
(d) All of these.
57. Tetany is caused by
- (a) Hypocalcemia  
(b) Hyperealcemia  
(c) Clostridium tetani.  
(d) Low  $\text{O}_2$  level
58. Which one of the following is an example of a non-elastic connective tissue?
- (a) Ligaments.  
(b) Tendon  
(c) Muscles.  
(d) None of these.
59. Which of the following muscle is an antagonistic member of Biceps brachii?
- (a) Brachioradialis  
(b) Brachialis.  
(c) Intercostals  
(d) Triceps
60. Insertion of Biceps is on
- (a) Ulna  
(b) Radius  
(c) Olecranon process of ulna.  
(d) Scapula
61. Which of the following statement is incorrect regarding the locomotion in Euglena?
- (a) Move with the help of flagellum, attached to the anterior pole of the body.  
(b) Flagellum whipping backwards moving the organism forward, and when moves forward the organism moves backward.  
(c) Myonemes can change the direction of the body by making it to shorten from anterior to the posterior pole.  
(d) None of these.
62. Which of the following animal uses Setae and Muscles for their locomotion?
- (a) Cockroach  
(b) Snail  
(c) Earthworm  
(d) Star fish
63. Which of the following vertebrates have a fish- like body?
- (a) Reptiles  
(b) Aves  
(c) Amphibians  
(d) Mammals
64. Which of the following pairs of fins in a fish body are paired?
- (a) Dorsal and ventral.  
(b) Pectoral and Pelvic.  
(c) Tail and anal  
(d) All of these.





65. Among the following organisms which shows the best adaptations for locomotion?  
(a) Amoeba. (b) Earthworm.  
(c) Reptiles (d) Amphibians.
66. Which of the following is the swiftest form of the locomotion?  
(a) Plantigrade (b) Digitigrade  
(c) Unguligrade (d) Hopping
67. S- band locomotion is characteristically seen in:  
(a) Bony fish (b) Cartilaginous fish.  
(c) Fish like mammals. (d) All fishes.



# Chapter 17

## COORDINATION & CONTROL

- Control through Hormones
- Responses to Environmental Stresses
- Defense Against Pathogens in Plants
- Biological Rhythms
- Plant Hormones

- Hypothalamus
- Thyroid Gland
- Islets of Langerhans
- Gut
- Comparison of Nervous & Chemical coordination

- Hormones
- Pituitary Gland
- Parathyroids
- Adrenals
- Gonads

- Innate Behaviour
- Learning Behaviour



### (II) Introduction & Coordination in Plants

### (III) Nervous Coordination in Animals

### (III) Chemical Coordination & Behaviour

- Evolution of Nervous System
- Human Nervous System
- Nervous Disorders

- Reflex Arc
- Nerve Impulse
- Synapse

- Receptor
- Neurons
- Effectors



- **Stimulus** is any factor, external or internal, at molecular, sub-cellular, cellular or organism level, to which the organism responds.
- Coordination in unicellular organisms exists between various cellular processes, while they respond to various changes in their surrounding environment.
- Coordination in multicellular organisms is highly developed involving a central controlling organ which works in association of several peripheral components like sensory receptors and effectors.

### COORDINATION IN PLANTS

- In plants, the control is solely by the plant hormone.
- Hormonal control is always a slow process, since there is delay between the releases, its arrival at the target cells, and its action in the body.
- Plants respond to the stimuli by:
  - Regulating their growth and Development in appropriate ways.
  - Controlling their body functions, through various plant and growth hormones.
- Plants living in certain deficiencies like nutritional deficiencies are called etiolated, absence of light results in extremely long plant which fails to synthesize chlorophyll. Such plants are called etiolated and process is called etiolation.
- Condition of leaves, showing yellowish hue resulting from their failure to form chlorophyll due to short supplies of mineral nutrients in the soil is called chlorosis.
- **Callus** is mass of amorphous material with very poor differentiation formed in a wounded plant.
- **Galls** are the growths on a plant that are induced by parasites. Those induced by bacteria are highly organized and less differentiated than other galls.

FEATURE	CALLUSES	GALLS
Production	When wounded	Induced by parasites especially bacteria
Natures	Masses of amorphous material with very poor differentiation	Amorphous material with differentiated/ less differentiated tissue
Area	Localized	May spread to other areas

### BIOLOGICAL CLOCK AND CIRCADIAN RHYTHMS

#### **BIORYTHMS OR BIOLOGICAL RHYTHMS**

- Behavioral activities occurring at regular interval are called biorhythms.
- Biorhythms showing periodicity of about 24 hours are called circadian rhythm.
- Biorhythms showing periodicity of 1 year or 365 days are circannual rhythms.
- Rhythms are in one's genes. The environment influences the rhythm to some extent.





## PLANT HORMONE

Part Affected	Auxins(IA(a))	Gibberellins	Cytokinins	Absciseic Acid	Ethene
Stem	<ul style="list-style-type: none"> <li>Promote cell enlargement behind apex.</li> <li>Promote cell division in cambium</li> </ul>	Same as that of auxins. promote cell enlargement in the presence of Auxins. Promote leaf growth.	Promote cell division in apical meristem and cambium. Promote leaf growth.	Inhibit during stress e.g., drought, waterlogging.	Same as that of absciseic acid
Root	Low conc. = promote growth. High conc. = inhibit growth e.g., Geotropism. Promote growth from cutting and calluses.		Inhibit primary root growth. Promote lateral root growth.		Inhibit root growth
Flower bud	Promote bud initiation	Promote bud initiation	Promote bud initiation. Promote lateral bud growth and break bud dormancy.	Promote bud initiation.	Promote bud initiation
Flowering		Promote in long day plants, inhibit in short day plants.		Promote in short day plants. Inhibit in long day plants.	Promote in pineapple
Apical dominance	Promote	Enhance action of Auxin.	Inhibit,		
Fruit growth	Promote	Promote	Promote		Fruit ripening
Parthenocarpy	Induce some times.	Promote	Rarely		
Leaf aging	Delay	Delay	Delay	Promote	
Seed dormancy		Break	Break	Promote.	
Abscission	Inhibit.			Promote.	
Stomatal opening.			Promote	Inhibit under stressful conditions.	
Commercial	NAA, IPA, 2,4 D	GA, GA <sub>3</sub>	( see below)	Regulate fruit dropping.	( see below)





## Commercial Application of Auxins

SYNTHETIC AUXIN	ROLE
NAA (Nephthalene acetic acid) Indole propionic acid.	Stimulate fruiting Sometime causes parthenocarpy.
2,4 D(2,4 Dichloro phenoxy acetic acid)	Selective weed killer. Kills weeds with broad leaves. Inhibit sprouting of potatoes. Prevent premature fruit drop (retard abscission).

## Commercial Application of Gibberellins

- *Gibberellins* are antagonistic (opposite) in action to Absciscic acid in terms of promotion or inhibition of flowering in long and short day plants.
- Promote fruit settings e.g., seedless grapes (parthenocarpy) & increase in the size of berry.
- $GA_3$  used in brewing industry to stimulate  $\alpha$ -amylase production in barley and this promotes malting.
- To delay ripening and to improve storage life of bananas and grape fruits.

## Commercial Application of Cytokinins:

- Delay aging (senescence) of fresh leaf crops
- Keeps flowers fresh.
- To break dormancy of some seeds.

## Commercial Application of Ethene

- Induces flowering in pineapple.
- Stimulate ripening of tomatoes and citrus fruits.
- Ethephone breaks down to release ethene and thus can be applied e.g., on rubber plant to stimulate the flow of latex.



1. \_\_\_\_\_ is mass of amorphous material with very poor differentiation formed in a wounded plant.
2. Biorhythms showing periodicity of about 24 hours are called \_\_\_\_\_.
3. \_\_\_\_\_ is used in brewing industry to stimulate  $\alpha$ -amylase production in barley and this promotes malting.
4. \_\_\_\_\_ breaks down to release ethene and thus can be applied e.g., on rubber plant to stimulate the flow of latex.
5. \_\_\_\_\_ plant hormone promotes lateral root growth.

Answers: (1) Callus (2) Circadian (3)  $GA_3$  (4) Ethephone (5) Cytokinin



**COORDINATION IN ANIMALS**

In almost all the animals' coordination is executed via neuronal and chemical (endocrine) systems.

**Neuronal Coordination**

Three basic components of nervous system are:

- 1) Receptors
- 2) Neurons
- 3) Effectors.

**Receptors**

A cell or a neuron or a receptor organ which can detect changes in the external and internal environment of the animal is called a receptor.

TYPE	SENSATION	EXAMPLES
Chemoreceptors	Smell, taste, blood $\text{CO}_2$ , $\text{O}_2$ , glucose, amino acids, fatty acids	Receptors in hypothalamus
Mechanoreceptors	Touch, pressure, hearing, equilibrium	Ear, skin, etc
Photoreceptors	Light	Eyes $\rightarrow$ rods, cones
Thermoreceptors	Cold & warmth	Receptors in skin.
Nociceptors	Pain	e.g., in skin.

**Working Of Sensory Skin Receptors**

- At least five different sensations are perceived by the skin, i.e., touch, pressure, heat, cold, and pain.
- There are at least three different types of sensory endings concerned with these sensations:

RECEPTOR	LOCATION	STRUCTURE	SENSATION
Free Nerve Endings.	At the base of hair.	Free nerve endings.	Touch
Meissner's Corpuscles	In papillae which extend into ridges of the fingertips.	Specialized cellular encapsulated corpuscles, Spiral and twisted endings, each ending in a knob.	Touch
Pacinian Corpuscles	Deep in the body.	Encapsulated neuron endings. Mostly located in the limbs.	Deep Pressure stimuli, vibration sensations.

**Distribution of Receptors in the Skin**

- Receptors are not evenly distributed through out the skin rather are located at the sites of specific function.
- Their relative abundance also varies e.g.,  
Pain receptors  $27 \times$  > Cold receptors.  
Cold receptors  $10 \times$  > heat receptors.

**NEURONS**

- It is the basic structural and functional unit of nervous system.
- Neurons can generate and conduct nerve impulses which travel across synapses and pass from receptors to effectors, bringing about nervous coordination.





- Neuroglia cells mostly present in higher animals, playing important role in nutrition of neurons and their protection by myelin sheath.
- They constitute nearly half of the nervous system.
- Neurons once matured do not divide any farther. However they exhibit limited regenerative capabilities, only if neural cell body is intact.

### Structure of Neuron

A typical neuron consists of

- 1) Cell body
- 2) Dendrites
- 3) Axons.

#### Cell Body

- Also called soma, is the chief nutritional part of the cell, synthesize material necessary for growth and multiplication of neuron.
- Contains nucleus and other cellular organelles, like E.R, ribosomes, G.A, mitochondria embedded in cytoplasm.
- Nissl's granules are group of ribosomes which are present in association with R.E.R
- If intact, the neuron can regenerate its axonal and dendrital components.

#### Axons

- The processes carrying impulses away from neuronal cell body are called axons.
- Cellular organelles like mitochondria, microtubules and neurofibrils, R.E.R. and G.A are present through out the axoplasm of the neuron.
- Most of the axons are surrounded by protective sheaths called myelin sheath, important for neuronal nutrition, protection and proper propagation of impulses.

#### Dendrites

- These are processes that carry impulses towards the cell body. They make synaptic contact with dendrites or axon of neighboring neurons.
- They unlike axon give a spiny look.

#### Types of Neurons

- There are three main types of neurons:
- **Sensory neurons** carry sensory information from receptors to associative neurons present in CNS.
- Most of them have only one fiber which divides a short distance from cell body into smaller branches.
- **Associative (intermediate/ relay) neurons** are present in CNS and convey the impulses to motor neurons.
- **Motor neurons** carry the information from relay neurons to effectors. They have a long axon, which is usually myelinated.

### EFFECTORS

- Structures which respond to stimuli received from motor neurons are called effectors.
- Glands → respond by secretion.
- Muscles → Respond by contraction.

### REFLEX ACTION / ARC

- Reflex action is a type of involuntary action.
- Reflex arc is the pathway of the passage of impulse during a reflex action.
- It includes:



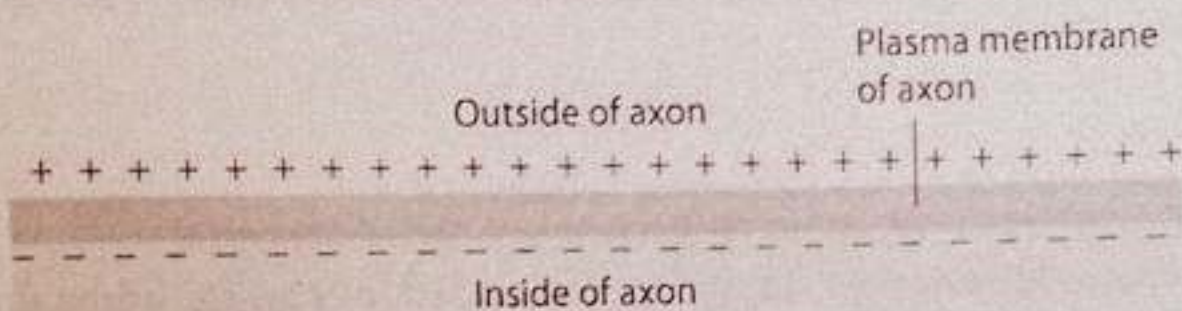
Receptors → Sensory neuron → Intermediate neurons → Motor neurons → Effectors →  
Bring about the desired action.

### Importance of Reflex Action

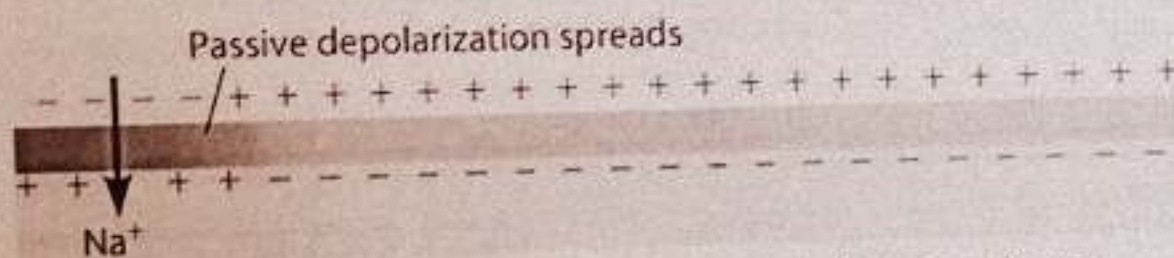
It helps an animal to save himself from danger e.g. when a person steps on a sharp object this message is immediately conveyed by the pain receptors to the spinal cord which results in contraction of the muscles of the leg and immediate withdrawal of the leg.

### NERVE IMPULSE

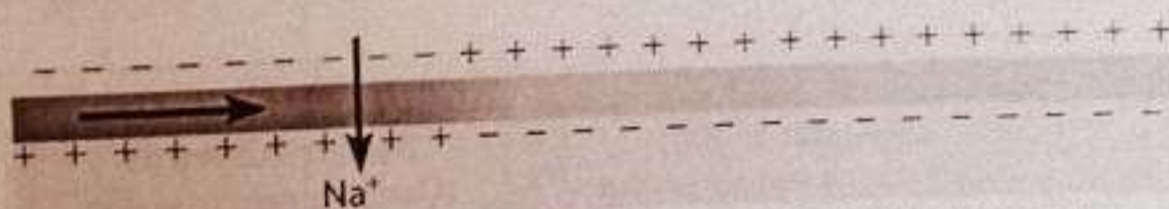
- Nerve impulse is a wave of electrochemical changes, which travels along the length of neurons involving movement of ions across the membrane.
- The electrical potential that exists across a cell membrane is called membrane potential. This may be a resting membrane potential if recorded across a resting neuronal membrane.



① At the start, the membrane is completely polarized.



② When an action potential is initiated, a region of the membrane depolarizes. As a result, the adjacent regions become depolarized.



③ When the adjacent region is depolarized to its threshold, an action potential starts there.



④ Repolarization occurs due to the outward flow of K<sup>+</sup> ions. The depolarization spreads forward, triggering an action potential.



⑤ Depolarization spreads forward, repeating the process.



**Speed of Nerve Impulse**

Normal speed in humans is 100 m/s but can reach upto 120 m/s.

**Repolarization**

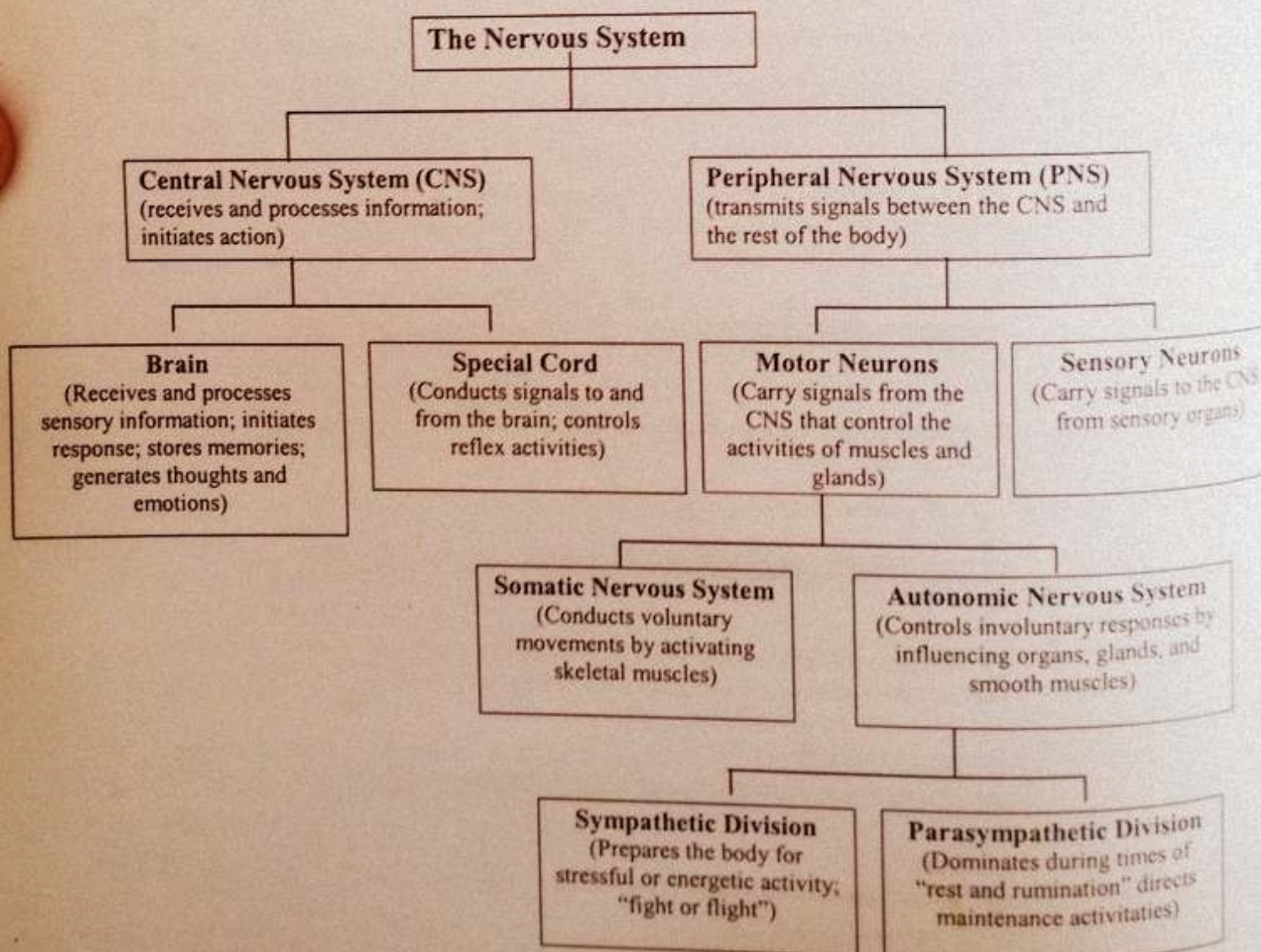
- It is the restoration of resting membrane potential, after the wave of depolarization has passed.
- Results from closure of  $\text{Na}^+$  gates and opening of  $\text{K}^+$  gates, without flux of  $\text{K}^+$  ions, causing repolarization
- $\text{Na}^+/\text{K}^+$  pump restore the original ionic gradient and thus the resting potential.
- The whole process of depolarization and repolarization takes about 2-3 milliseconds

**Saltatory Impulse**

The jumping of nerve impulse from node to node in myelinated nerve ending is called saltatory impulse.

**SYNAPSES**

- Cytoplasmic gaps between consecutive neurons are called *synapse*.
- **Acetylcholine** is neurotransmitter for synapse outside CNS while adrenalin, nor-epinephrin, serotonin and dopamine in CNS.





HUMAN BRAIN

BRAIN	PARTS	SUBPARTS	FUNCTIONS
Forebrain	Thalamus		Relay station for sensation from eye, ear, skin & internal receptors
	Limbic system	Hypothalamus	Hormone production, coordinating center, control body temperature, hunger, menstrual cycle, water balance, sleep-wake cycle.
		Amygdale (cluster of neurons)	Sensation of pleasure, punishment, sexual arousal, feeling of fear & rage
		Hippocampus	Long-term memory, learning
	Cerebrum	Largest part, two halves (cerebral hemispheres) communicating with corpus callosum (band of axons), outer cerebral cortex forming convolutions (increasing surface area)	Receives sensory information, processes it, stores in form of memory, direct voluntary movement, responsible for thinking, intelligence, reasoning, judgment. Sensory area, speech area, motor area; right cerebral hemisphere controls left side of body
Midbrain (reduced in man)	Reticular formation		Relay center connecting hindbrain with forebrain, screening input information, contains auditory relay station,
Hindbrain	Pons		Influence transition between sleep & wakefulness, controls rate & pattern of breathing
	Medulla		Controls autonomic functions e.g. breathing, heart rate, blood pressure, swallowing
	Cerebellum (best developed in birds)		Coordinates voluntary movements, guides smooth & accurate motions, maintains body position, learning & memory storage for behaviours.

NERVOUS DISORDERS

- **Parkinson's disease** is a nervous disorder, characterized by involuntary tremors, diminished motor power and rigidity.
- **Epilepsy** is a convulsive disorder of nerves characterized by abrupt transient symptoms of motor, sensory, psychic or autonomic nature, frequently associated with changes in consciousness.
- **Alzheimer's disease** (first described by Alois Alzheimer) is characterized by decline in brain function.

CHEMICAL COORDINATION

- **Endocrine system** consists of some 20 endocrine glands.
- **Hormones** are organic compounds of varying structural complexity.



- **Pituitary gland** (hypophysis cerebri) is an ovoid structure about 0.5 gm in adult and connected to brain through a short stalk called infundibulum.
- Anterior lobe of pituitary gland is considered as **master gland**.



1. At least \_\_\_\_\_ different sensations are perceived by the skin.
2. Neuroglia constitute nearly \_\_\_\_\_ of nervous system.
3. Reflex action is a type of \_\_\_\_\_ action.
4.  $\text{Na}^+$  ions are concentrated on \_\_\_\_\_ side of neuron.
5. Cytoplasmic gaps between consecutive neurons are called \_\_\_\_\_.
6. Largest part of human brain is \_\_\_\_\_.
7. \_\_\_\_\_ influences transition between sleep and wakefulness.
8. \_\_\_\_\_ is a nervous disorder, characterized by involuntary tremors, diminished motor power and rigidity.

Answers: (1) 5 (2) half (3) Involuntary (4) Outside (5) Synapse (6) Cerebrum (7) Pons (8) Parkinson's Disease

### ENDOCRINE SYSTEM OF MAN

Gland	Secretion	Control of production	Function	Oversecretion	Undersecretion
<b>Hypo-thalamus</b>	ADH & oxytocin	Sensory stimuli	Given Below		
<b>Anterior pituitary</b>	STH	SRF	Controls growth	Gigantism/Acromegaly	Dwarfism
	TSH	TRF	Controls thyroid		
	ACTH	CRF	Control of adrenal cortex	Disturbance of normal adrenal function	
<b>(Gonadotrophins)</b>	FSH	LHRF (common with LH)	<ul style="list-style-type: none"> <li>• In female follicle development &amp; estrogen secretion.</li> <li>• In male, development of germinal epithelium of testis &amp; sperm production</li> </ul>		
	LH (ICSH in male)	LHRF	<ul style="list-style-type: none"> <li>• Estrogen secretion, ovulation, maintenance of corpus luteum, progesterone secretion in female.</li> </ul>		





			<ul style="list-style-type: none"> <li>In male, testosterone secretion</li> </ul>		
	Prolactin (LTH)	PIF	Alongwith LH maintains and stimulates progesterone, milk production		
Median pituitary	MSH	External light	Stimulation of melanocyte to produce melanin		
Posterior pituitary	ADH/ vasopressin	Decrease in blood pressure, blood volume, osmotic pressure detected by osmoreceptors of hypothalamus, external sensory stimuli	Controls level of water in body by affecting reabsorption at distal parts of nephron	Concentrated urine	Diabetes insipidus
	Oxytocin	By distension of cervix, decreased progesterone level in blood, neural stimuli during parturition and suckling	Contraction of smooth muscles of uterus during childbirth and milk ejection		
Thyroid (2 lobes above larynx)	T <sub>4</sub> and T <sub>3</sub>	TSH	Increasing basic metabolic rate, growth, differentiation of brain cells, metamorphosis in amphibians	Graves disease characterized by exophthalmic goiter	Cretinism in children & Myxedema in adults
	Calcitonin	High Ca <sup>++</sup> in blood stimulates and low retards.	Control of calcium level in blood	Disturbance of calcium metabolism with affect on nerves, skeleton, blood muscle etc.	



Parathyroid	Parathormone	Low $Ca^{++}$ in blood stimulates and high suppresses.	Calcium level in blood	Progressive demineralization of bones (like rickets), formation of kidney stones	Drop in blood calcium level leading to muscle tetany
Pancreas (Islets of Langerhans)	Insulin (by $\beta$ -cells, which are more in number))	STH, ACTH & blood glucose level	Decreases blood glucose level by converting into glycogen, lipid & proteins, increasing utilization & decreasing hydrolysis of glycogen	Hypoglycemia, upset of nerve and muscle function	Diabetes Mellitus
	Glucagons (by $\alpha$ -cells, which are smaller in number)	STH, ACTH & blood glucose level	Increases breakdown of glycogen and fats into glucose	Rare, tumors causing oversecretion, which leads to high blood glucose level & damage of alpha and beta cells	
Adrenal (2 on top of kidneys) Adrenal Medulla	Adrenalin	Stress	Vasodilation (skeletal muscles), increase in cardiac output, release of glucose from glycogen, reinforcing sympathetic system, increase in blood pressure	Overactivity	Person cannot face and prepare in emergency condition
	Noradrenalin	Stress along with adrenalin	Vasoconstriction (Gut)	Same as above	
Adrenal Cortex	Corticosterone & androgens	ACTH	Increase in blood glucose level antagonistic to insulin, $Na^+$ uptake, and secondary sexual characters.	Cushing's disease	Addison's disease
Gut	Gastrin	Protein food in stomach	Stimulates secretion of gastric juice		
	Secretin from duodenum	Acidic food in duodenum	Stimulates pancreas and liver to produce pancreatic juice and bile respectively		
Ovaries	Oestrogen from ripening follicles & interstitial cells	FSH	Development of secondary sexual characters in female, thickening of uterine wall during menstrual cycle, rise in LH, healing & repair of uterine wall after menstruation, protein provision to embryo.		Sexual retardation in young and sterility in adults
	Progesterone from ruptured follicle	LH	Inhibits FSH secretion, inhibits follicle ripening, thickening and vascularization of uterus,		





			maintains pregnancy, suppresses ovulation		
Testes (interstitial cells)	Testosterone & 17 $\beta$ -hydroxytestosterone	ICSH (LH)	Development of sex organs in foetus and secondary sexual characters in adult, sex drive		Castration before puberty leads to failure of secondary sexual characters with female appearance

### COMPARISON OF NERVOUS AND CHEMICAL COORDINATION

NERVOUS COORDINATION	CHEMICAL COORDINATION
Neurons (sensory, associative and motor) are the basic units of structure and function.	Hormones producing cells and neurosecretory cells (such as those found in the hypothalamus) release hormones and are units of structure and function.
Chemicals produced by neuron endings act where they are produced i.e. very close to the cells they influence, commonly from less than a micrometer away. For example, acetylcholine produced by nerve endings at synapse, and excites the next neuron.	Chemicals produced (the hormones or neuro-hormones) are produced into and are transported by blood. These hormones affect the target cells, which are far away from where hormones are produced. ADH is produced from posterior lobe of pituitary gland but affects the target cells present in the nephron and collecting tubule of kidney, to control re-absorption.
In this system, the neuron releases its neurotransmitter into one or a small group of specific cells.	The blood borne hormones bathe million of cells indiscriminately and only a few respond to these hormones.
This has immediate effect or show response to a stimulus instantly.	They may have immediate effects (e.g. insulin) but mostly hormones have prolonged or delayed effects for example growth hormones.
This control is affected through the electrical signals that travel within the cell itself and it releases its neurotransmitters only where it reaches its target.	This control involves only chemical stimulation and the target cells are far away from them.
This shows faster or rapid effect. The speed of impulse in most cases is 100 m/s but maximum speed recorded in humans is 120 m/s.	It is not very rapid but shows slow but prolonged effects.
The chemicals involved in this system (the neurotransmitters or neuro hormones) are short lived i.e. broken down shortly after their release. Thus the effects of messengers sent by neurons tend to be of much shorter duration.	The hormones are the chemicals which remain active for much longer duration within the blood and thus have much longer duration for their actions.

### BEHAVIOUR

- Innate behaviour** is collection of responses that are predetermined by the inheritance of specific nerves or cytoplasmic pathways in multicellular or unicellular organism.



- All plant behaviour is innate.
- *Kinesis* is the behaviour in which an organism changes the speed of random movements which help them to survive in the environment.
- *Taxes* is a directed movement.
- A *sign stimulus* is a part of stimulus configuration and may be relatively simple.

### COMPARISON BETWEEN INSTINCTIVE BEHAVIOUR AND LEARNING BEHAVIOUR

INSTINCTIVE BEHAVIOUR	LEARNING BEHAVIOUR
This is the type of behaviour that depends on the hereditary material which the animal inherits. The animal may be born with the right responses built in the nervous system as part of inherited structure.	This type of behaviour also depends upon the environmental influence, but the ability to modify its behaviour depends on the hereditary material.
Experience has no obvious role on this type of behaviour.	Experience has an obvious influence on this type of behaviour.
This type of behaviour depends on the selection operating during the history of species, so that it helps in the adaptability of the organism in the environment.	This type of behaviour depends on the selection operating during the history of the individual (during one's life time) so as to help the organism in its adaptability in the given environment.
Instinct can equip an animal with a series of responses. This is advantageous for animals with short life span and with little or no parental care.	Learning can equip an animal with a set of adaptive responses to its environment. This is advantageous for those animals which have long life spans and have parental care, so that they can modify the behaviour by previous experience.
This type of behaviour evolves slowly in the species.	This type of behaviour evolves during the life cycle of the individual but the ability of learning depends on the genetic basis of the individual.
For example: i) Honey bee inherits the ability to form wing muscles and wings for flight. They inherit the tendency to fly towards flowers to seek nectar and pollen. ii) Behaviour of digger wasp is instinctive but it does learn certain things during its brief life, such as locality of each of its nests where it has to return after hunting.	For example: i) Conditioned reflex type I, in case of dogs where dogs learn to salivate on ringing of bell alone. ii) Trial and error learning in case of cat, when it learns to press the lever to open the door of the cage. iii) Crawling snail on the sheet of glass learns that tapping has no harmful effect and ceases to respond after few early responses.



LEARNING BEHAVIOUR

- Thorpe defined **learning** as that process which manifests itself by adaptative changes in individual behaviour as a result of experience.
- Such type of learning in which birds follow any moving object is called **imprinting**.
- **Habituation** is no gain of new responses but loss of old ones.
- **Conditioned reflex type I** involves the pairing of an irrelevant stimulus within a natural primary stimulus that elicits an automatic response.
- Conditioned reflex type I was explained by Pavlov.
- **Oparent conditioning** or conditioned reflex type II (trial and error learning) was explained by Thorndike and B.F Skinner.
- Thorpe defined **latent learning** as the association of indifferent stimuli or situations without patent reward.
- **Insight learning** is an extreme case of behavioral modification involving the application of insight or reasoning to a novel situation.
- Insight learning was explained by Kohler in chimpanzee.



1. Oversecretion of STH in later age causes \_\_\_\_\_.
2. LH is called \_\_\_\_\_ in male.
3. MSH is produced from \_\_\_\_\_ pituitary.
4. Insulin is produced from \_\_\_\_\_ cells of pancreas.
5. A \_\_\_\_\_ is a part of stimulus configuration and may be relatively simple.
6. \_\_\_\_\_ behaviour evolves slowly in the species.
7. Learning was first defined by \_\_\_\_\_.
8. \_\_\_\_\_ is an extreme case of behavioral modification involving the application of insight or reasoning to a novel situation.

Answers: (1) Acromegaly (2) ICSH (3) Median (4)  $\beta$  (5) Sign Stimulus (6) Instinctive (7) Thorpe (8) Insight Learning





## VALUES

Property	Value
Amount of neuroglia	$\frac{1}{2}$ of nervous system
Concentration of $\text{Na}^+$ outside than inside	10 times
Concentration of $\text{K}^+$ inside than outside	20 times
Resting membrane potential	0.07 volts (-70 mv)
Active membrane potential	0.05 volts (-50 mv)
Normal speed of nerve impulse	100 meters per second
Maximum speed of nerve impulse	120 meter per second
Number of layers of Meninges	3
Number of neurons in cerebrum	Tens of billions
Cranial nerves	12 pairs
Spinal nerves	31 pairs
Endocrine glands in man	20





## PRACTICE EXERCISE



1. Chlorosis, i.e., yellowish hue on the leaves results from
  - (a) Accumulation of toxic waste products in leaves.
  - (b) Deficiency of chlorophyll.
  - (c) Short supplies of mineral nutrients in the soil.
  - (d) All of these
2. Chemically auxins are
  - (a) Indole propionic acid.
  - (b) Indole carboxylic acid.
  - (c) Indole acetaldehyde.
  - (d) Indole acetic acid.
3. Gibberellins may be substituted for \_\_\_\_\_ light, therefore promote flowering in long day plants.
  - (a) White
  - (b) Red
  - (c) Blue
  - (d) Green
4. Which of the following is antagonist to Auxin in terms of promotion of stem growth?
  - (a) Gibberellins
  - (b) Cytokinins
  - (c) Abscissic Acid
  - (d) None of these.
5. Abscissic acid promotes flowering in short day plants and inhibits in long day plants, Which of the following is antagonistic to abscissic acid in terms of flowering:
  - (a) Gibberellins
  - (b) Cytokinins
  - (c) Auxins
  - (d) Ethene.
6. The only promoter of leaf senescence in the following plant hormones is:
  - (a) Gibberellins
  - (b) Cytokinins
  - (c) Auxins
  - (d) Abscissic Acid
7. Which of the following is used in brewing industry to promote malting:
  - (a) Gibberellins
  - (b) Cytokinins
  - (c) Auxins
  - (d) Abscissic Acid
8. Which type of the receptors are present in the ear?
  - (a) Chemoreceptors
  - (b) Mechanoreceptors
  - (c) Photoreceptors
  - (d) Thermoreceptors
9. Type of sensations carried by nociceptors are:
  - (a) Touch.
  - (b) Temperature.
  - (c) Pressure.
  - (d) Pain
10. Which type of sensory structures carrying the touch sensations are present in papillae extending into ridges of the fingertips?
  - (a) Hair end organs
  - (b) Meissner's Corpuscles.
  - (c) Pacinian corpuscles.
  - (d) None of these.
11. Which type of sensory structures carry deep pressure and vibration sensations?
  - (a) Hair end organs
  - (b) Meissner's Corpuseles.
  - (c) Pacinian corpuscles.
  - (d) None of these.
12. Nissl's granules are present in which part of the neuron?
  - (a) Axoplasm
  - (b) Myelin sheath.
  - (c) Dendrite.
  - (d) Soma.



13. Which of the following statement about neuron is incorrect?  
(a) They not only conduct impulses but also generate them.  
(b) They are not the only cellular component of nervous system.  
(c) They may show limited regenerative capabilities.  
(d) Like all the living cell, when they mature and divide to form similar cells.
14. Type of neurons found exclusively in CNS are:  
(a) Sensory neurons  
(b) Motor neurons  
(c) Associative neurons  
(d) None of these.
15. Maintenance of normal resting potential via movement of  $K^+$  inside the cell and  $Na^+$  out is a/an \_\_\_\_\_ process.  
(a) Active  
(b) Passive  
(c) Diffusional  
(d) None of these.
16. Cell membrane under resting conditions is impermeable to all the ions except  
(a)  $Na^+$   
(b)  $K^+$   
(c)  $Cl^-$   
(d)  $PO_4^{2-}$
17. At the induction of action potential opening of  $Na^+$  gate with influx of  $Na^+$  is a \_\_\_\_\_ processes:  
(a) Active transport.  
(b) Passive transport.  
(c) Diffusion.  
(d) None of these.
18. Normal resting membrane potential of a neuron is  
(a) - 50 mv  
(b) - 60 mv  
(c) - 70 mv  
(d) - 80 mv
19. Normal action potential of a neuronal cell is:  
(a) + 50 mv  
(b) + 60 mv  
(c) + 70 mv  
(d) + 80 mv
20.  $Na^+-K^+$  ATPase pump is important for;  
(a) Maintenance of resting potential.  
(b) Massive out flux of  $K^+$  after depolarization.  
(c) Recovery of resting potential.  
(d) Conversion of resting potential into action potential.
21. Maximum speed of nerve impulse transmission is  
(a) 100 m/sec  
(b) 110 m/sec  
(c) 120m/sec.  
(d) 130 m/sec.
22. Which of the following has no central nervous system?  
(a) Hydra  
(b) Man  
(c) Planaria  
(d) Cockroach
23. Co-ordination results in  
(a) Regulation of body functions  
(b) Organization of body functions  
(c) Integration of body functions  
(d) All of these
24. Which of the following are responsible for the detection of changes in environment?  
(a) Receptors  
(b) Neurons  
(c) Effectors  
(d) All of these
25. Which of the followings are effectors?  
(a) Muscles  
(b) Glands  
(c) Sensory organs  
(d) Both 'a' & 'b'
26. Any change in the environment of an organism is called  
(a) Stimulus  
(b) Variation  
(c) Response  
(d) Reaction





27. Hydra has
  - (a) Brain
  - (b) Nerves
  - (c) Neuron cells
  - (d) All of these
28. Which of the followings is missing from the nervous system of planaria?
  - (a) Ganglia
  - (b) Longitudinal nerves
  - (c) Lateral nerves
  - (d) None of these
29. Co-ordination in man is brought about by
  - (a) Nervous system
  - (b) Endocrine system
  - (c) Both of these
  - (d) None of these
30. Which of the following transmits nerve impulse from receptors to central nervous system?
  - (a) Sensory neuron
  - (b) Motor neuron
  - (c) Associative neuron
  - (d) None of these
31. In which of the following neurons length of dendrite is greater than axon?
  - (a) Sensory neuron
  - (b) Motor neuron
  - (c) Associative neuron
  - (d) None of these
32. Which of the following neuron has a single long dendron?
  - (a) Sensory neuron
  - (b) Motor neuron
  - (c) Associative neuron
  - (d) None of these
33. Which of the following cytoplasmic extensions carry the message toward the cell body?
  - (a) Dendrites
  - (b) Axon
  - (c) Both of these
  - (d) None of these
34. Microscopic gaps between the neuron endings are called
  - (a) Transmitters
  - (b) Synapses
  - (c) Pores
  - (d) Nodes
35. What is the function of synapse?
  - (a) To allow nerve impulse to move in backward direction
  - (b) To decrease the speed of nerve impulse
  - (c) To stop the nerve impulse
  - (d) To provide cytoplasmic connection between neurons.
36. Under resting membrane potentials
  - (a) Outer surface of neuron is more positive
  - (b) Inner surface of neuron is more positive
  - (c) Both of these surfaces are equally positive
  - (d) None of these
37. Which of the following ions are involved in the initiation of nerve impulse
  - (a)  $\text{Na}^+$
  - (b)  $\text{K}^+$
  - (c) Fe
  - (d) None of these
38. Reflex actions below the neck are under control of
  - (a) Brain
  - (b) Spinal cord
  - (c) Hypothalamus
  - (d) None of these
39. Central nervous system of man consists of
  - (a) Brain
  - (b) Spinal cord
  - (c) Both of these
  - (d) None of these
40. Which of the following is largest part of brain
  - (a) Cerebrum
  - (b) Cerebellum
  - (c) Medulla oblongata
  - (d) Thalamus



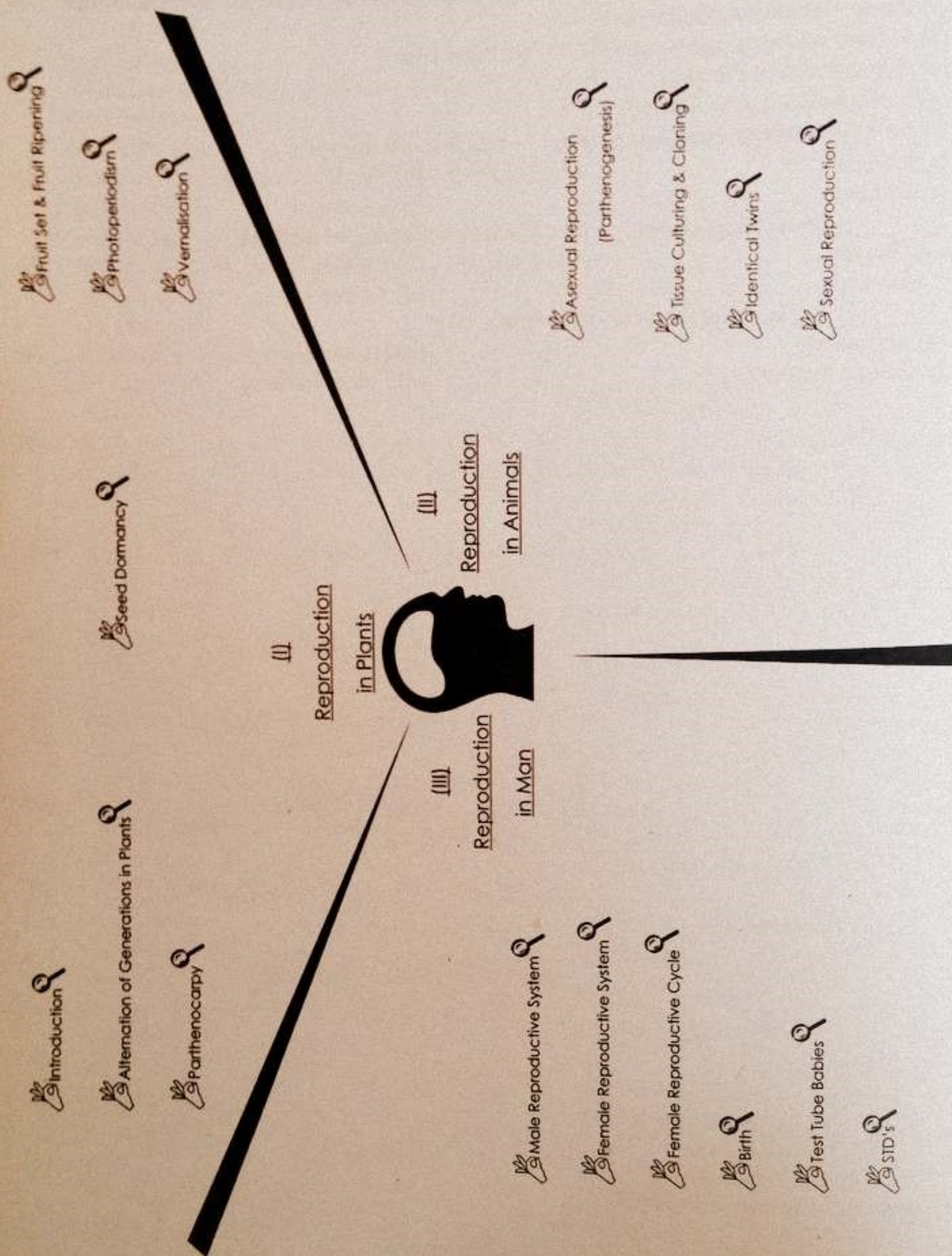


41. Which of the following is present inside the vertebral column  
 (a) Brain (b) Spinal cord  
 (c) Both of these (d) None of these
42. Intelligence is under the control of  
 (a) Cerebrum (b) Cerebellum  
 (c) Thalamus (d) Hypothalamus
43. Which of the following is second largest part of the brain?  
 (a) Cerebrum (b) Cerebellum  
 (c) Thalamus (d) Hypothalamus
44. Which of the following acts as thermoregulator?  
 (a) Cerebrum (b) Cerebellum  
 (c) Thalamus (d) Hypothalamus
45. Which of the following allows precise muscular movements?  
 (a) Cerebrum (b) Cerebellum  
 (c) Thalamus (d) Hypothalamus
46. Receptors for hearing come under heading of  
 (a) Chemical (b) Mechanical  
 (c) Photo (d) Nociceptors
47. It is one of the convulsive disorders of nerves which are characterized by abrupt transient symptoms of motor, sensory, psychic or autonomic nature.  
 (a) Parkinson's disease (b) Epilepsy  
 (c) Alzheimer's disease (d) Dementia
48. Which of the following feature is not related to neuron  
 (a) Conduction (b) Regeneration  
 (c) Reflex (d) Movement
49. Value of resting membrane potential is  
 (a) 0.03 V (b) 0.05 V  
 (c) 0.07 V (d) 0.09V
50. Number of pairs of cranial nerves is  
 (a) 10 (b) 11  
 (c) 12 (d) 13
51. Insufficient secretion of iodothyroxine in adults causes  
 (a) Myxedema (b) Cretinism  
 (c) Goiter (d) Exophthalmic goiter
52. Insulin and glucagons are \_\_\_\_\_ in nature.  
 (a) Protein (b) Amino acid derivative  
 (c) Polypeptide (d) Steroid
53. Acromegaly is caused due to oversecretion of  
 (a) STH (b) TSH  
 (c) ACTH (d) Thyroxin
54. MSH is produced from  
 (a) Anterior pituitary (b) Median pituitary  
 (c) Posterior pituitary (d) None of these
55. Grave's disease is produced due to  
 (a) Undersecretion of thyroxin (b) Overproduction of thyroxin  
 (c) Undersecretion of corticosteroids (d) Overproduction of corticosteroids



56. Secretin is a hormone produced by  
(a) Stomach (b) Liver  
(c) Pancreas (d) Duodenum
57. All of the following are similarities between nervous and endocrine system except  
(a) Produce chemical messengers  
(b) Release chemical messengers in extracellular space  
(c) Homeostatic in function  
(d) Having slow but prolonged effects
58. Types of behaviour enabling pillbugs to reach moist area is  
(a) Kinesis (b) Taxes  
(c) Instinct (d) Learning
59. \_\_\_\_\_ was first to propose an objective definition of instinct.  
(a) Thorpe (b) Darwin  
(c) Pavlov (d) Kohler
60. \_\_\_\_\_ is simplest form of learning.  
(a) Imprinting (b) Habituation  
(c) Insight learning (d) Latent learning









### CONCEPT OF REPRODUCTION

- **Reproduction** is the mechanism that produces new generations and maintains a species.
- Reproduction is of **two types**, asexual and sexual reproduction.
- **Asexual reproduction** requires only a single parental organism which gives rise to offspring by mitotic cell division; offspring are genetically identical to the parent.
- In **Asexual Reproduction** offspring are genetically identical to the parents while in sexual type chromosome number is halved in offspring.
- **Methods of asexual reproduction** are fission, sporulation, budding, vegetative propagation, artificial propagation, parthenogenesis, apomixes.
- **Sexual reproduction** usually involves two parents, a fertilized egg is produced through the union of meiotically produced specialized sex cells from each parents.

### REPRODUCTION IN PLANTS

- In plants both asexual and sexual reproduction are found.
- In sexual reproduction plants have **diplohaplontic life cycle** with alternating **diploid sporophyte** and **haploid gametophyte** generations.
- There are two types of alternation of generations i.e. isomorphic (homomorphic) and heteromorphic.
- In **isomorphic**, generations are vegetatively similar while dissimilar in **heteromorphic**.
- **Pollen tubes** act as vehicle for male gametes for their safe transport to female gamete in ovule in hostile land environment.

### PARTHENOCARPY

- Development of fruit without fertilization and seed formation is called **parthenocarpy**.
- **Examples** are Banana, pineapples, some varieties of oranges and grapes.
- Due to hormonal imbalance, **high auxin levels** occur in these ovaries.

### SEED DORMANCY

- **Seed dormancy** is special condition of rest, which enables an embryo to survive the long periods of unfavorable environmental conditions such as water scarcity or low temperature.
- It prevents the dormant seed from germinating in response to conditions like warm spell in winter which are only temporary.
- Resumption of normal growth by a dormant embryo is called germination.

### FRUIT SET AND FRUIT RIPENING

- **Fruit set** is retention of ovary which becomes the fruit after fertilization.
- **Auxin** produced by ovary and ripe seeds is necessary for fruit set.
- Developing seeds are a rich source of auxins, gibberellins and cytokinins.
- Fruit ripening is often accompanied by a burst of respiratory activity called **climacteric**.
- Climacteric is associated with ethane production helping in fruit ripe.



### PHOTOPERIODISM

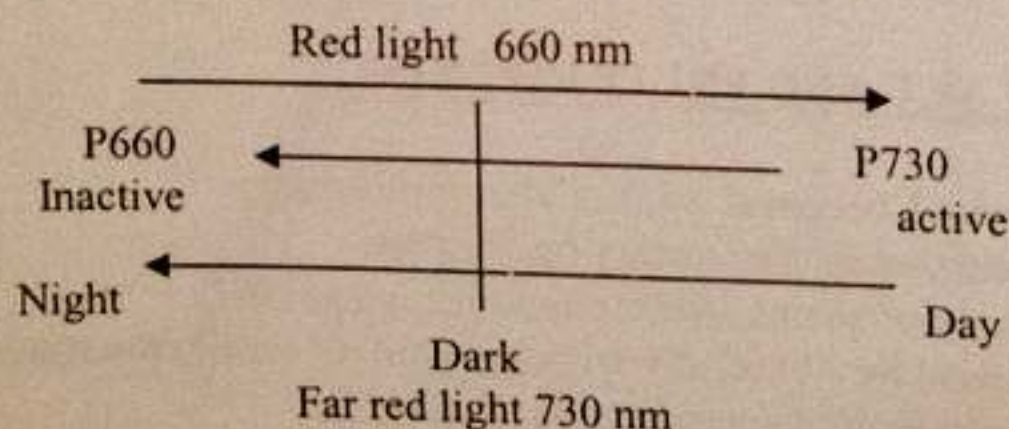
- **Photoperiodism** was first studied by *Garner* and *Allard* in 1920 by studying tobacco plant.
- It is the **length of the dark period** which is critical thus short day plants are really long night plants.
- **Day neutral plants** are those in which flowering is independent of photoperiod e.g. cucumber, tomato, garden pea, maize, cotton

#### Photoperiodic Classification of Plants

FEATURE	SHORT DAY PLANTS	LONG DAY PLANTS
Dark period	Flowering when day period is more than critical length so also called long night plants.	Flowering when day period is less than critical length so also called short night plants.
Day period	Flowering when day period is less than critical value.	Flowering when day period is more than critical value.
Effect of red light	Prevents flowering	Promotes flowering
Effect of far-red light	Promotes flowering	Prevents flowering
Examples	Cocklebur ( <i>Xanthium</i> ), <i>Chrysanthemum</i> , soyabean, tobacco, strawberry	Henbane ( <i>Hyoscyamus niger</i> ), snapdragon, cabbage, spring wheat, spring barley.

**Phytochromes** are blue light sensitive protein pigments and exist in two forms i.e. P660 and P730.

GENERAL PROCESS EFFECTED	RED LIGHT PROMOTES
1) Germination	Some seeds e.g. some lettuce varieties
2) Photomorphogenesis (light-controlled development of form and structure)	<ul style="list-style-type: none"> <li>• Leaf expansion in dicotyledons.</li> <li>• Leaf unrolling in grasses (monocotyledons).</li> <li>• Chloroplast development (Etioplasts → chloroplast).</li> <li>• Greening (protochlorophyll → chlorophyll).</li> <li>• Inhibiting of internodes/etiolation (including epicotyl, hypocotyls, mesocotyl).</li> <li>• Unhooking of plumule in dicotyledons</li> </ul>
3) Photoperiodism	Stimulates flowering in long-day plants and inhibits in short day plants





VERNALIZATION

- Flowering stimulated by low temperature (in biennials and perennial) is called *vernalisation*.
- Low temperature stimulus is received by shoot apex of a mature stem or embryo of the seed but not by leaves as in photoperiodism



1. \_\_\_\_\_ is the mechanism that produces new generations and maintains a species.
2. Development of fruit without fertilization and seed formation is called \_\_\_\_\_.
3. Resumption of normal growth by a dormant embryo is called \_\_\_\_\_.
4. Fruit ripening is often accompanied by a burst of respiratory activity called \_\_\_\_\_.
5. \_\_\_\_\_ are blue light sensitive protein pigments.
6. Flowering stimulated by low temperature (in biennials and perennial) is called \_\_\_\_\_.

REPRODUCTION IN ANIMALS

- Development of an egg into zygote without fertilization is called *parthenogenesis*.
- **Examples:** ants, bees, wasps
- In *haploid parthenogenesis*, haploid egg develops into haploid offspring.
- In *diploid parthenogenesis* egg producing cells of the female retain the diploid number of chromosomes.
- In *honey bee* male are haploid and produce sperms by mitosis, in *aphids* females are diploid
- Formation of seed without fertilization is called *apomixes*.
- In apomixes a diploid cell of the ovule develops into embryo in the absence of the male gamete

CLONING

- Production of organisms of valuable characteristics from a single cell by subculturing without a change in their genetic makeup is called cloning and the organisms produced are called *clones*

Egg cell without nucleus + Diploid somatic cell nucleus → Clones

- **Disadvantages** are rapid aging, low resistance to environmental stress and diseases
- **Clones** are identical to the parent who has contributed the nucleus

Answers: (1) Reproduction (2) Parthenocarp (3) Germination (4) Climacteric (5) Phytochromes (7) Vernalization



IDENTICAL TWINS

- Identical twins are the organisms produced by the separation of two blastomeres of the embryo when it is at two cell stage, each cell giving rise to the organism having identical genetic makeup.
- They are produced mitotically.

FEATURE	IDENTICAL TWINS	FRATERNAL TWINS
Genetic Make Up	Identical	Different
Cell Division	Mitotically (Asexually)	Sexually
Production	Separation of blastomeres at two cell stage	Formation of two different zygotes

SEXUAL REPRODUCTION

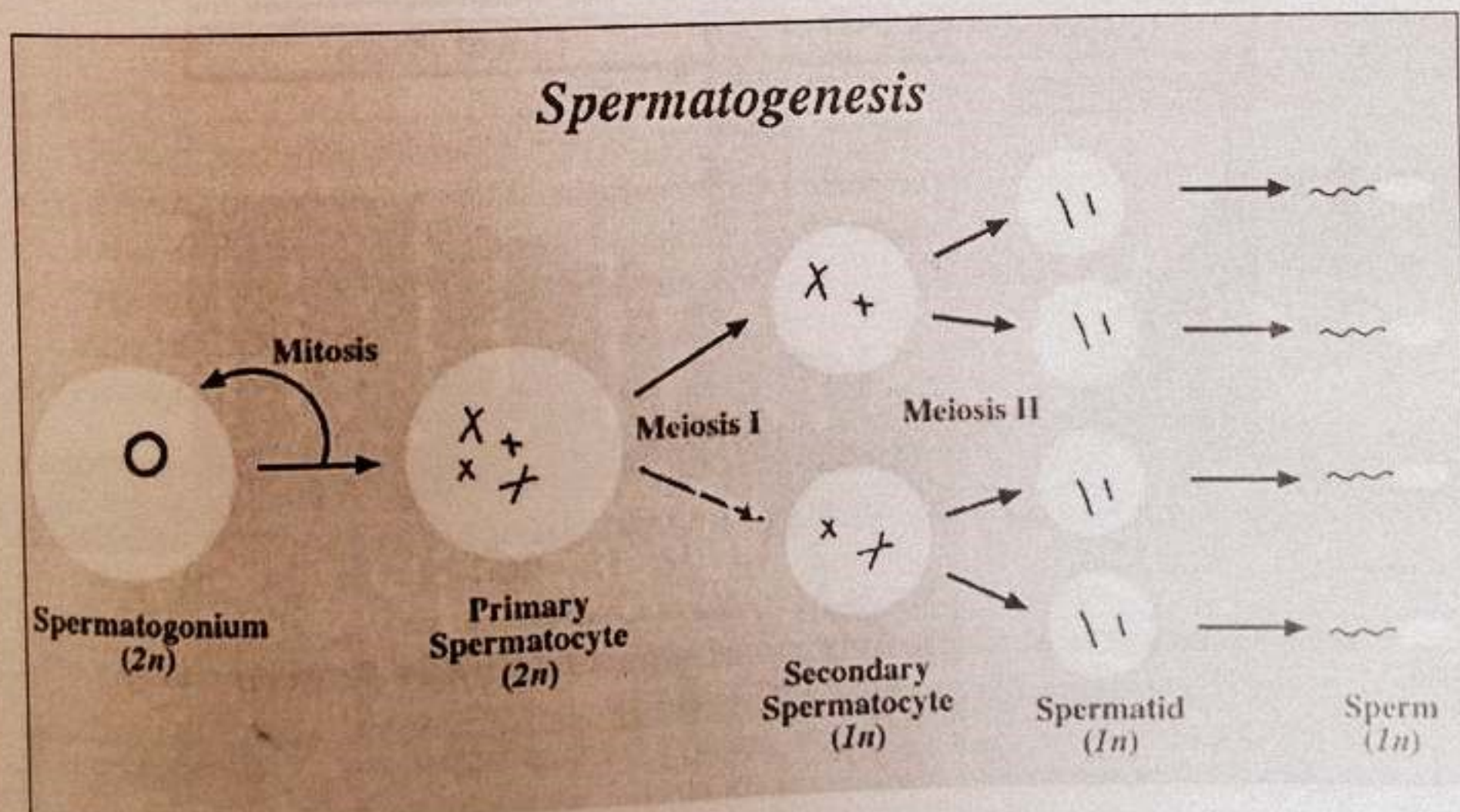
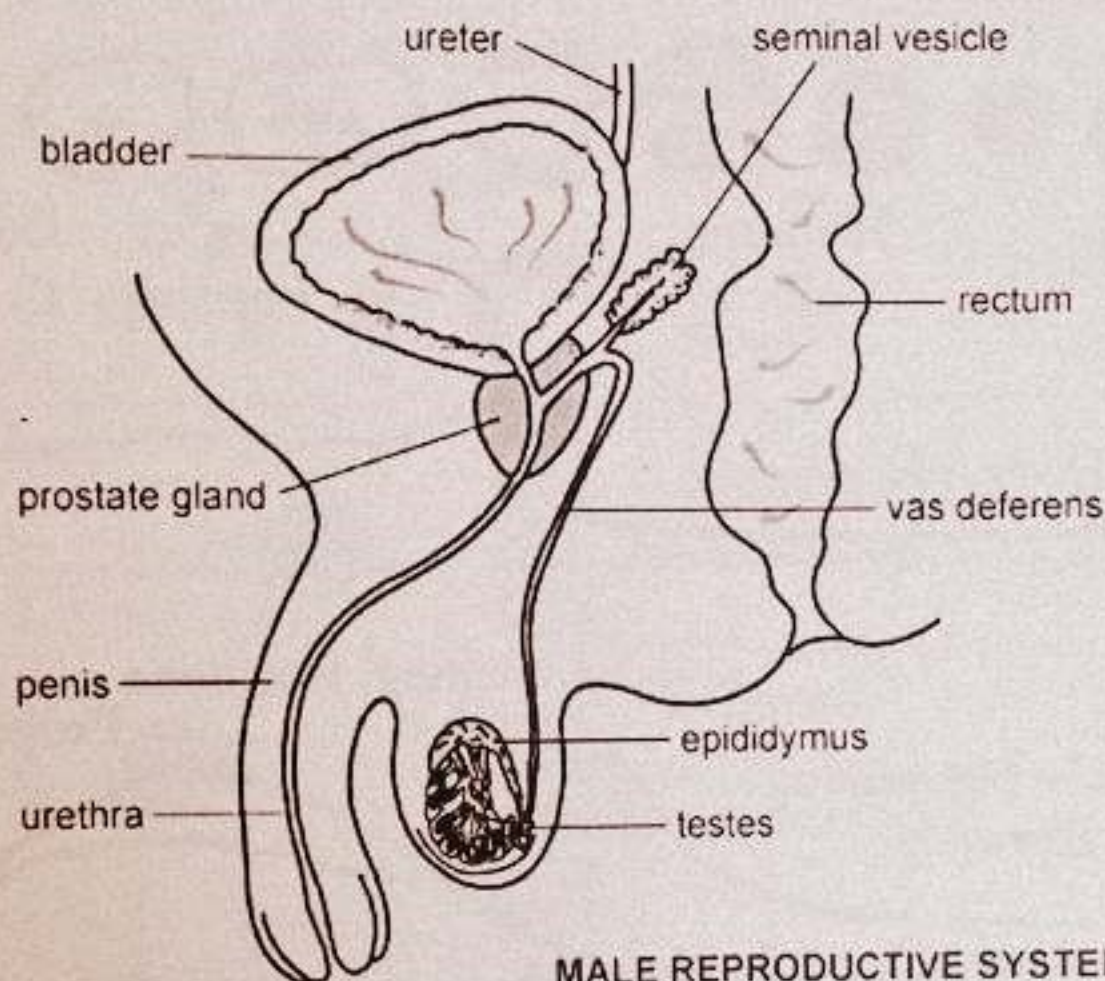
- Hermaphrodites** are organisms having both sexes
- External fertilization** occurs in water and development is also external e.g. frog, fish
- Internal fertilization** occurs on land, development may be external or internal
- In **oviparous** there is internal fertilization but development is external in shelled eggs e.g. reptiles and birds
- In **viviparous** there is internal fertilization with internal development accomplished inside the female body e.g. mammals
- In **ovaviviparous** internal fertilization and internal development is followed by hatching of egg (e.g. Duckbill platypus i.e. *Arachnida*).

ASEXUAL REPRODUCTION	SEXUAL REPRODUCTION
1 parent only	Usually 2 parents
No gametes are produced	Gametes are produced. These are haploid and nuclei of 2 gametes fuse (fertilization) to form a diploid zygote
Meiosis absent	Meiosis is present at some stage in lifecycle to prevent chromosome doubling in every generation
Offspring identical to the parent	Offspring not identical to the parent. They show genetic variation as a result of genetic recombination
Commonly occurs in plants, less differentiated animals and microorganisms. Absent in more differentiated animals	Occurs in majority of plant and animal species
Often results in rapid production of large no. of offspring	Less rapid increase in number



MALE REPRODUCTIVE SYSTEM

- Male gonads consist of a **pair of testes**, which lie outside the body, in sac-like scrotum.
- **Penis** is external genitalia, which is used to transfer sperm into female reproductive tract.
- **Sertoli cells**, which provide liquid medium, protection and nourishment to cells while they are in the tubules.
- **Interstitial cells** are present between the seminiferous tubules and secrete testosterone essential for production of sperms and development of male secondary sexual characteristics.

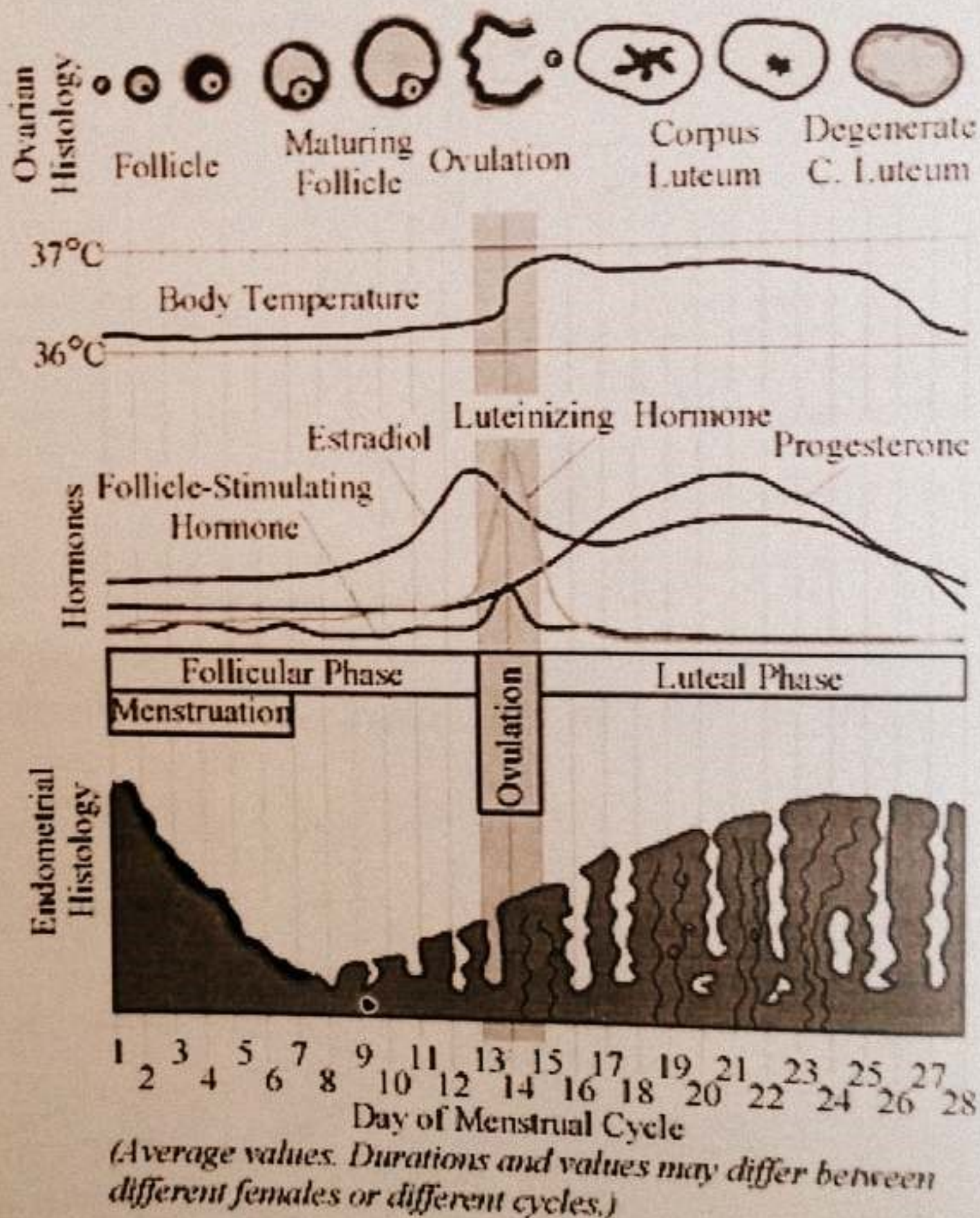




# Chapter 18

## FEMALE REPRODUCTIVE SYSTEM

- *Vagina* is external genitalia in female.
- Discharge of ovum from ovary is called *ovulation*.
- Fertilization of ovum occurs in *proximal part of oviduct*.
- Oestrous cycle is reproductive cycle in all females' mammals except humans. At this stage female is on heat i.e. exhibits the desire for mating

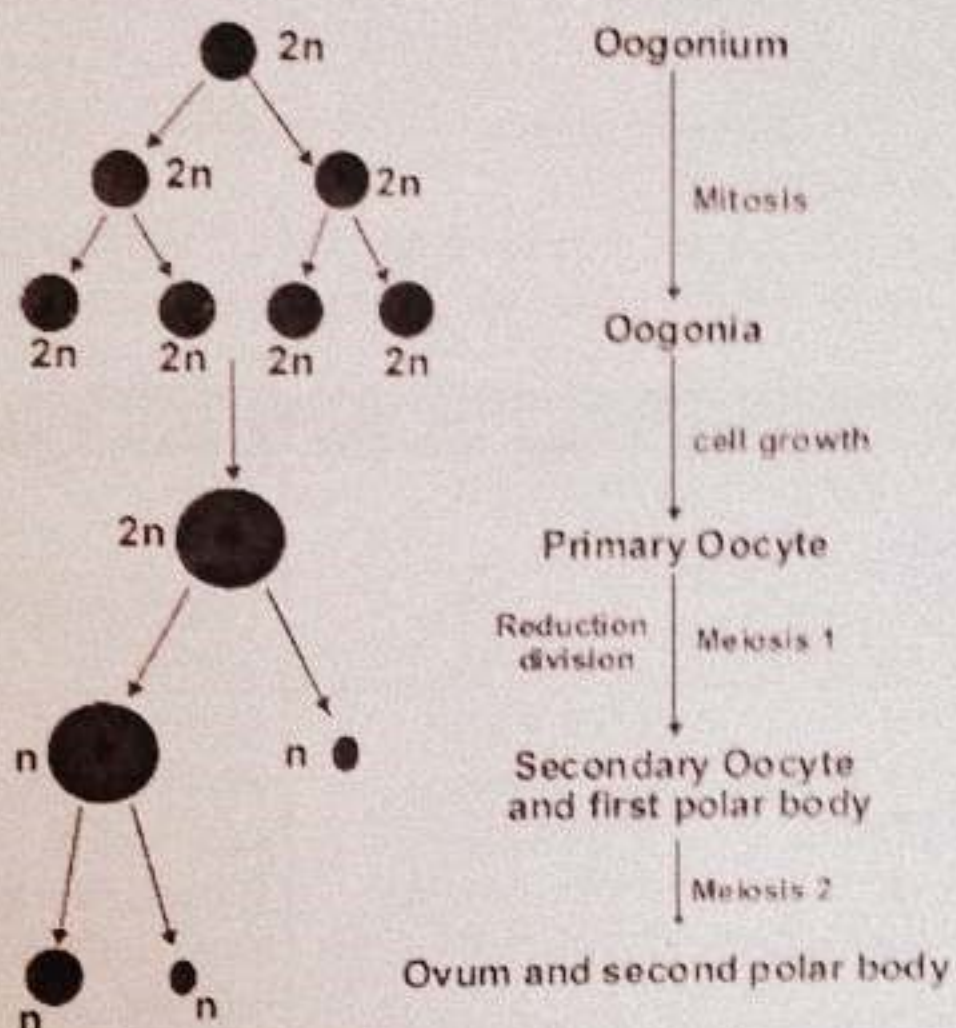


### Female Reproductive Cycle

- In human female, *menstrual cycle* of 28 days occur involving structural and functional changes.
- *Events of menstrual cycle* involve the ovaries (ovarian cycle) and uterus (uterine cycle).



- Process by which other follicles degenerate is called *follicle atresia*.
- Follicle cells after ovulation convert into yellowish glandular *corpus luteum* which secretes progesterone.
- *Leutinizing hormone* causes ovulation.
- The end or complete stop of menstrual cycle is called *menopause*.
- *Menstruation stage* lasts for 3-7 days



### Birth

- The total *gestation period* (pregnancy) is about 280 days.
- *LTH and human placental lactogen* stimulate mammary development for lactation
- *Fetus* is human embryo from the beginning of 3<sup>rd</sup> month of pregnancy
- Expulsion of placental materials outside the vagina is called *after birth*, occurs within 10-45 min after birth
- Average loss of blood during birth is about  $350\text{cm}^3$

FEATURE	MALE REPRODUCTIVE SYSTEM	FEMALE REPRODUCTIVE SYSTEM
Gonads	Pair of testes	Pair of ovaries
External Genitalia	Pair of testes & scrotum	Vagina
Duct system	Seminiferous tubules, epididymis, vas deferens, urethra	Oviduct, uterus, vagina
Gametogenesis	Spermatogonia > Primary spermatocyte > Secondary spermatocyte > Spermatid	Oogonia > Primary oocyte > Secondary oocyte + first polar body > Egg



TEST TUBE BABIES

Placental sperm and ovum is fertilized in vitro and then zygote is implanted back into mother uterus where remaining development occurs.

SEXUALLY TRANSMITTED DISEASES

- **Gonorrhea** is caused by gram positive *Neisseria gonorrhoeae* and affects mucous membranes of urinogenital tract.
- **Syphilis** is caused by spirochete *Treponema pallidum*, which damages reproductive organs, eyes, bones, joints, CNS, heart and skin.
- **Genital herpes** is caused by herpes simplex type II virus and produces genital soreness and ulcers in the infected areas. If it is transmitted to fetus may cause damage to eyes and CNS.

Feature	Gonorrhea	Syphilis	Genital Herpes	AIDS
Casual Agent	Gram positive bacteria	Spirochete	Virus	Virus
Cause	<i>Neisseria gonorrhoeae</i>	<i>Treponema pallidum</i>	Herpes simplex type II	HIV
Main parts Affected	Mucous membrane of urinogenital tract, eye infection to baby	Damage to reproductive organs, eyes, bones, joints, CNS, heart, skin.	Infection of genitalia, genital soreness & ulcers, damage to eyes & CNS in infants.	Destruction of immune system
Source of Transmission	Sexual contact	Sexual contact	Sexual contact	Sexual contact



1. Formation of seed without fertilization is called \_\_\_\_\_.
2. Identical twins are produced \_\_\_\_\_.
3. In \_\_\_\_\_ internal fertilization and internal development is followed by hatching of egg.
4. \_\_\_\_\_, which provide liquid medium, protection and nourishment to sperm cells while they are in the tubules.
5. Fertilization of ovum occurs in \_\_\_\_\_ of oviduct.
6. Process by which primary follicles degenerate is called \_\_\_\_\_.
7. \_\_\_\_\_ is caused by herpes simplex type II virus and produces genital soreness.

(1) Apomixis (2) Mitotically (3) Oviviparous (4) Sertoli Cells  
(5) Proximal Part (6) Follicle Atresia (7) Genital Herpes

Answers:



## ----- VALUES -----

Property	Value
Critical dark length of cocklebur	8.5 hours
Critical day length of cocklebur	15.5 hours
Critical dark length of tobacco	10-11 hours
Critical day length of tobacco	13-14 hours
Critical dark length of henbane	13 hours
Critical day length of henbane	11 hours
Effective temperature for vernalization	4°C
Duration of menstrual cycle	28 days
Phases of menstrual cycle	4
Events of menstrual cycle	2
Duration of menstruation	3-7 days
Total gestation period (pregnancy)	280 days
Major organ formation	12 week of pregnancy
Time for after birth	10-45 minutes
Average loss of blood during birth	350 cm <sup>3</sup>





## PRACTICE EXERCISE

 30 min  
Time Yourself

1. In asexual reproduction offspring are produced by
  - (a) Meiosis
  - (b) Mitosis
  - (c) Both a and b
  - (d) None of these
2. Which method is of asexual reproduction?
  - (a) Sporulation
  - (b) Fission
  - (c) Apomixis
  - (d) All of these
3. Gametes in animals are produced by
  - (a) Mitosis
  - (b) Meiosis
  - (c) Fission
  - (d) Apomixis
4. In sexual reproduction, plants have diplohaplontic life cycle with alternating
  - (a) Diploid sporophyte and haploid gametophyte generations
  - (b) Haploid sporophyte and diploid gametophyte generations
  - (c) Diploid sporophyte and diploid gametophyte generations
  - (d) Haploid sporophyte and haploid gametophyte generations
5. Which statement is correct?
  - (a) In heteromorphic generations are vegetatively dissimilar
  - (b) In isomorphic generations are vegetatively dissimilar
  - (c) In isomorphic generations are vegetatively similar
  - (d) Both a and c
6. In parthenocarpy which levels are high in ovaries
  - (a) Gibberalins
  - (b) Cytokinins
  - (c) Auxins
  - (d) All of these
7. Seeds are dormant in conditions of
  - (a) Water scarcity
  - (b) Low temperature
  - (c) Harsh winters
  - (d) All of these
8. Developing seeds are rich source of
  - (a) Auxins
  - (b) Gibberellins
  - (c) Cytokinins
  - (d) All of these
9. Which statement is incorrect?
  - (a) Climacteric is burst of respiratory activity in fruit ripening
  - (b) It is associated with ethane production
  - (c) It helps in fruit set
  - (d) It helps in fruit ripening
10. What is critical in photoperiodism?
  - (a) Length of light period
  - (b) Length of dark period
  - (c) Both a and b
  - (d) None of these
11. Which one is not a day neutral plant?
  - (a) Cucumber
  - (b) Maize
  - (c) Cotton
  - (d) Tobacco





12. Which statement is incorrect?
  - (a) In short day plants red light prevents flowering
  - (b) Henbane is a short day plant
  - (c) In long day plants far red light promotes flowering
  - (d) Leaf unrolling occurs in grasses
13. In biennials and perennials, low temperature stimulus is not received by
  - (a) Shoot apex of mature stem
  - (b) Embryo of the seed
  - (c) Leaves of the plants
  - (d) None of the above
14. Development of an egg into zygote without fertilization is called
  - (a) Parthenogenesis
  - (b) Apomixes
  - (c) Parthenocarp
  - (d) None of these
15. In which organism males are haploid
  - (a) Aphids
  - (b) Honey bee
  - (c) Mosquito
  - (d) Butterfly
16. In cloning, nucleus is introduced into
  - (a) Somatic cell
  - (b) Egg cell
  - (c) Sperm cell
  - (d) None of these
17. Which characteristic is not of identical twins?
  - (a) Produced by separation of two blastomeres
  - (b) Have different genetic makeup
  - (c) Produced asexually
  - (d) Produced when embryo is at two cell stage
18. Viviparous animals are those in which
  - (a) Internal fertilization with external development in eggs
  - (b) Internal fertilization with internal development inside female body
  - (c) Internal fertilization and internal development followed by hatching of egg
  - (d) External fertilization with external development
19. Example of ovoviviparous
  - (a) Reptiles
  - (b) Mammals
  - (c) Duckbill platypus
  - (d) Frog
20. Sertoli cells
  - (a) Provide liquid medium to cells in testes
  - (b) Provide protection and nourishment to cells
  - (c) Secrete testosterone
  - (d) Both a and b
21. 2<sup>nd</sup> meiotic division in oocyte is completed
  - (a) When ovum is discharged from the ovary
  - (b) When oocyte is fertilized by sperm
  - (c) Just before fertilization
  - (d) Before the onset of menstruation
22. Fertilization of ovum occurs
  - (a) In proximal part of oviduct
  - (b) In distal part of oviduct
  - (c) In uterus
  - (d) In ovary



23. Duration of menstrual cycle is
  - (a) 25 days
  - (b) 26 days
  - (c) 27 days
  - (d) 28 days
24. Progesterone is secreted by
  - (a) Ripening follicles
  - (b) Uterine epithelium
  - (c) Corpus luteum
  - (d) Fertilized egg
25. Total gestation period is about
  - (a) 350 days
  - (b) 200 days
  - (c) 280 days
  - (d) 320 days
26. Fetus is human embryo from the beginning of
  - (a) 2<sup>nd</sup> month
  - (b) 3<sup>rd</sup> month
  - (c) 4<sup>th</sup> month
  - (d) 5<sup>th</sup> month
27. Average loss of blood during birth is about
  - (a) 250 cm<sup>3</sup>
  - (b) 350 cm<sup>3</sup>
  - (c) 450 cm<sup>3</sup>
  - (d) 150 cm<sup>3</sup>
28. Which statement is incorrect?
  - (a) Syphilis is caused by *Treponema pallidum*
  - (b) Genital herpes produces genital soreness and ulcers
  - (c) Syphilis affects eyes, bones, joints, CNS
  - (d) Gonorrhea is caused by gram negative bacterium
29. The animals in which there are separate male and female individuals are called
  - (a) Unisexual
  - (b) Bisexual
  - (c) Hermaphrodite
  - (d) None of these
30. In which of the following animals, placenta is formed?
  - (a) Prototherians
  - (b) Metatherians
  - (c) Eutherians
  - (d) None of these
31. Which of these cycles operate in human females?
  - (a) Oestrous cycle
  - (b) Menstrual cycle
  - (c) Both of these
  - (d) None of these
32. During birth which of following act as birth canal?
  - (a) Oviduct
  - (b) Uterine tube
  - (c) Uterus
  - (d) Vagina
33. Nutrition to egg in ovary is provided by
  - (a) Germ cells
  - (b) Follicle cells
  - (c) Milk cells
  - (d) None of these
34. End of menstrual cycle in old age is called
  - (a) Andropause
  - (b) Menopause
  - (c) Gametopause
  - (d) All of these
35. Critical day length for cocklebur is
  - (a) 8.5 hrs
  - (b) 10-11 hrs
  - (c) 13-14 hrs
  - (d) 15.5 hrs
36. In asexual reproduction offspring are genetically
  - (a) Identical to the parents
  - (b) Non identical to the parents
  - (c) Identical if mutations do not occur.
  - (d) Both a and c





37. Evolution of pollen tube is parallel to the evolution of  
(a) Leaf (b) Plant  
(c) Flower (d) Seed
38. Resumption of normal growth by a dormant embryo is called  
(a) Seed dormancy (b) Germination  
(c) Fruit set (d) Fruit ripening
39. \_\_\_\_\_ is a quiescent form of phytochrome.  
(a) P630 (b) P660  
(c) P730 (d) P760
40. Apomixis is a form of  
(a) Parthenocarpy (b) Vernalization  
(c) Parthenogenesis (d) None of these



- Meristems
- Types of Growth
- Phases of Growth
- Conditions of Growth
- Differentiation
- Growth Constraints

Growth & Development

in Plants

Growth & Development

in Animal

- Concept of Differentiation
- Embryonic Induction

- Role of Cytoplasm in Development
- Role of Nucleus in Development

- Development of Chick
- Mechanism of Development

- Wounding
- Regeneration
- Neuronal Development





- The progressive changes which are undergone before an organism acquires its adult form constitute *embryonic development*.
- Permanent and irreversible increase in size that occurs as an organism matures is called *growth*.

### GROWTH AND DEVELOPMENT IN PLANTS

- In plants growth and development occur in four steps:
  - Cell division
  - Cell elongation
  - Cell maturation
  - Cell differentiation
- **Development:** is a programmed series of stages from a simpler to more complex form.
- In plants growth pattern is called *open growth*
- Growth does not occur in same constant speed i.e.  
First slow → then rapid → attains maximum → then gradually slows
- **Meristems** are young tissues or group of cells that retain the potential to divide.
- **Growing points** are also called meristems and consist of groups of cells which are capable of division.
- **In lower plants** entire body is capable of growing.
- **In higher plants** growth is limited to certain regions called growing points
- There are **three types** of meristems i.e. apical, intercalary and lateral meristems.

#### Types of Meristem

Feature	Apical Meristem	Intercalary Meristem	Lateral Meristem
Location	Tips of root & stem	Base of internodes	Cambium
Plants	In all plants	In all plants especially grasses	Gymnosperms & dicot
Role	Primary growth (increase in length of plant)	Production of leaves & flowers	Secondary growth (increase in width)
Nature	Permanent	Temporary	Permanent

- Leaves, flower and fruits are grown to a certain size and then stop. It is called *determinate growth*.
- Vegetative root and shoot grow by meristems that continually replenish themselves called *indeterminate growth*.

### TYPES OF GROWTH IN PLANTS

- Growth is of two types:
  - Primary growth
  - Secondary growth



- In *primary growth*, primary tissue is added by apical meristems.
- In *secondary growth*, secondary tissue is added by intercalary or vascular cambium causing increase in thickness.

### PHASES OF GROWTH

Growth of multicellular plants occur in 4 phases

#### **Cell division**

- Cells increase in size by mitosis.
- It is associated with cells located at tips of roots and shoots.
- Cells are small, have spherical nuclei.
- Cytoplasm non vacuolated

#### **Cell elongation**

- A little distance from tips of roots and shoots.
- By uptake of water, plasticity of cell wall increases and wall pressure is reduced

#### **Cell maturation**

- Final size is achieved.
- Pith and cortex do not elongate further along the axis.
- Cells of fibres and tracheids elongate lengthwise more.

#### **Cell differentiation**

- Walls of cells become thick
- Walls of xylem vessels thicken.
- Walls also become pitted.
- New structural features develop

### CONDITIONS OF GROWTH

#### **External Factors**

##### **Temperature**

- Maximum optimum temperature for growth of plants is 25-30 °C and least is 5-10 °C.
- Normal range of temperature for growth is 0-35°C.
- Growth stops at 35-40°C.
- Growth and temperature have a directly proportional relationship.

##### **Light**

- Light affects growth in three ways i.e. intensity, quality and duration.
- Red light favours elongation of cells.
- Blue light enhances cell division but retards cell enlargement like UV rays.
- Duration of light plays a role in inducing or suppressing flowering called *photoperiodism*

##### **Oxygen**

Very high supply of oxygen inhibits growth

##### **Carbon dioxide**

Decrease or increase in concentration of CO<sub>2</sub> also effects growth.

#### **Internal Factors**

##### **Hormones**

IAA causes elongation of cells



**Water**

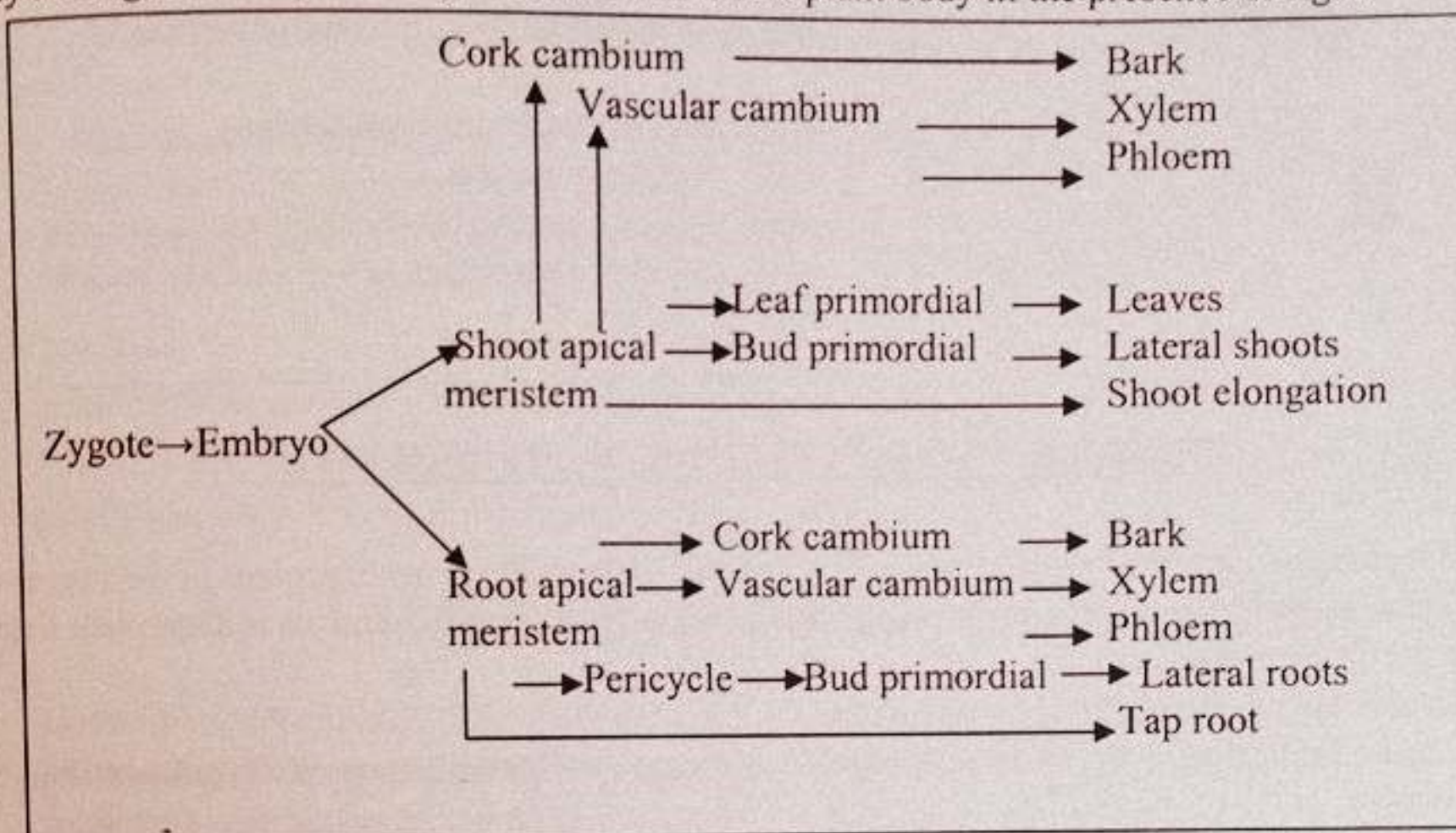
Cells elongate by absorbing water

**Nutrition**

Directly proportional relationship with growth

**Vitamins**

They are organic compounds synthesized within the plant body in the presence of light.

**DIFFERENTIATION**

- **Differentiation** is formation of specialized tissue.
- Occur in 5 stages:  
 Stage 1 → Stage 2 → Stage 3 → Stage 4 → Stage 5  
 Embryo → apical meristems → cambium forms → leaf, root and shoot Primordials → full differentiation

**GROWTH CORRELATIONS**

- Different plant parts grow in different directions and different rates. Such reciprocal relationship is called **correlation**.
- Such type of correlative effect in which growth of apical buds suppresses lower axillary buds is called **apical dominance**.
- Apical dominance was experimentally preferred by Thimann and Skoog in 1934.
- Apical bud inhibited the growth of lateral shoots called **inhibitory effect**.
- Removal of apex releases the lateral buds from apical dominance. It is called **compensatory effect**.
- **Auxins** diffusing from the apical buds cause apical dominance while **Cytokinins** if applied directly on the inhibited bud allows lateral buds to be released from apical dominance.





1. Permanent and irreversible increase in size that occurs as an organism matures is called \_\_\_\_\_.
2. \_\_\_\_\_ are young tissues or group of cells that retain the potential to divide.
3. Normal range of temperature for growth is \_\_\_\_\_ °C.
4. Formation of cambium represents \_\_\_\_\_ stage of differentiation.
5. Such type of correlative effect in which growth of apical buds suppresses lower axillary buds is called \_\_\_\_\_.

### GROWTH AND DEVELOPMENT IN ANIMALS

- **Embryology** is study of growth and differentiation undergone by an organism in the course of its development from a single fertilized egg into a highly complex and an independent living being like his parents
- Key events in animal's development  
Gamete formation → Fertilization → Cleavage → Gastrulation → Organogenesis → Growth

### DEVELOPMENT OF CHICK

#### **Fertilization and Incubation**

- Fertilization is internal.
- At 36-38 °C the chick completes development and is hatched on 21<sup>st</sup> day.

#### **Cleavage**

- Series of mitotic divisions in fertilized egg is called *cleavage*.
- Cleavage confined to small disc of protoplasm laying on the surface of yolk at animal pole (as in birds) is called *discoidal cleavage*.
- First and second cleavage are vertical while third is horizontal and then it becomes irregular.

#### **Morula**

Rounded closely packed mass of blastomeres resulting from cleavage is called *morulla*.

#### **Blastula**

- **Blastula** is characterized by presence of segmentation cavity or **blastocoel**.
- The discoidal cap of cells above the blastocoele is called **blastoderm**

#### **Gastrulation**

- Characterized by movement and rearrangement of cells.
- **Epiblast** is presumptive ectoderm and mesoderm and **hypoblast** is endoderm.

Answers: (1) Growth (2) Meristems (3) 0-35°C (4) 3<sup>rd</sup> (5) Apical Dominance





- Translucent area of fluid raising central cells of blastoderm separating from yolk is called *area pellucida*.
- Peripheral part of blastoderm making contact with yolk is called *area opaca*.

#### Notochord and Mesoderm Formation

- Local thickening of closely packed cells at cephalic end of primitive streak is called *Hensens's node*.
- Marginal area where expanding germ layers merge with underlying yolk is known as *germ wall*.
- Cavity between the yolk and the endoderm called *gastrocoele* then changes to *primitive gut*.
- Dorsal mesoderm organizes into *somites*
- Cavity formed between somatic and splanchnic mesoderm is called *coelom*

#### Neurulation

- When neural plate is formed embryo is called *neurula*
- Anterior part of neural tube develops into brain while posterior part into spinal cord
- Cavity enclosed in neural tube is called *neurocoel*

### MECHANISMS OF DEVELOPMENT

- *Hans Dietrich* explained mechanism of development in sea urchin in 1892.
- *Spemann* explained mechanism of development in salamander zygote.
- *Gray crescent* is the pigment free area that appears at time of fertilization. Its position is important in development.
- All cells contain the same nuclear information

#### Role of Cytoplasm in Development

- Fertilized egg of an ascidian contains cytoplasm of four different colors that is segregated into different blastomere.
- **Clear cytoplasm** → produces larval epidermis
- **Yellow cytoplasm** → gives rise to muscle cells
- **Gray vegetal cytoplasm** → gives rise to gut
- **Grey equatorial cytoplasm** → produces notochord and neural tube

#### Role of Nucleus in Development

- *Acetabularia mediterranea* has regular shaped cap and *A. cranulata* has irregular shaped cap.
- Experiments on *Acetabularia* were performed by *Haemmerling* showing role of nucleus in development.

### CONCEPT OF DIFFERENTIATION

- *Spemann* performed experiments on amphibian embryo to explain differentiation.
- Mesodermal cells have some effect on the ectoderm to stimulate ectodermal cells to form nervous system.



- Cytoplasmic components that control the functioning of a specific cell type are morphogenetic determinants.

### EMBRYONIC INDUCTION

- Hans Spemann and Hilde Mangold worked on *embryonic induction* in 1924.
- Dorsal lip area is *primary organizer* which causes development which is called *primary induction*.

### AGING

- *Aging* can be defined as negative physiological changes in our body.
- Study of aging is called *gerontology*.
- Aging occurs because of limited mitotic divisions, changing in intracellular substances and spontaneous mutation.

#### **SIGNS AND EFFECTS OF AGING**

Loss of hair
Development of small pigmented areas in the skin of face and arms
Dryness and wrinkling of skin
Loss of agility
Increased weight due to fat
Poor vision
Forgetfulness
General weakness
Decreased body immunity
Degeneration of cartilage in joints leading to arthritis
Degeneration of elastic tissue in tunica media of blood vessels leading to arteriosclerosis
Blood clotting in coronary arteries.
Increased cross linkages in collagen.

### REGENERATION

- The ability to regain or recover the lost or injured part of the body is called *regeneration*.
- Among invertebrates, **sponges** possess great power of regeneration.
- Regeneration occurs because of **retention of undifferentiated cells**

Group	Example	Part Regenerated
<b>Invertebrates</b>	Sponge	Can regenerate any part
	Lobster	Pincer claw
	Starfish	Portions of arms if central disc survives
	Earthworm	Head
<b>Vertebrates</b>	Salamander	Limbs
	Frog	Limbs but only during metamorphosis
	Lizard	Tail
	Man	Healing of fracture & repair of bone



ABNORMAL DEVELOPMENT

- **Teratology** is branch of biology, which deals with abnormal development and its causes.
- Environmental factors causing abnormal development are called **teratogens** e.g. ionizing radiation (X-rays).

CAUSE	EFFECT	EXAMPLES
Genetic defects	Defective gene, dominance or recessive gene, homozygous or heterozygous	Hemophilia
Chromosomal abnormalities	Extra chromosome or missing chromosome	Klinefelter's syndrome, Turner's syndrome
Environmental factors	<ul style="list-style-type: none"> <li>• Ionizing radiations</li> <li>• Nutritional deficiencies</li> </ul>	<ul style="list-style-type: none"> <li>• Mutations</li> <li>• Effect on differentiation</li> </ul>
Metabolic defects	Structural deviation during organogenesis	Microcephaly, Cleft palate, Microdactyl, Polydactyl



1. Series of mitotic divisions in fertilized egg is called \_\_\_\_\_.
2. Blastula is characterized by presence of segmentation cavity \_\_\_\_\_.
3. Local thickening of closely packed cells at cephalic end of primitive streak is called \_\_\_\_\_.
4. Cavity enclosed in neural tube is called \_\_\_\_\_.
5. \_\_\_\_\_ can be defined as negative physiological changes in our body.
6. Among invertebrates, \_\_\_\_\_ possess great power of regeneration.
7. \_\_\_\_\_ is branch of biology, which deals with abnormal development and its causes.

Answers: (1) Cleavage (2) Blastocoel (3) Hensen's Node (4) Neurocoel (5) Aging (6) Sponges (7) Teratology



## VALUES

Property	Value
Temperature range for normal growth	0-35°C
Optimum temperature for maximum growth	25-30°C
Temperature for least growth	5-10°C
Incubating temperature for development of chick	36-38°C
Incubating period for development of chick	21 days
Number of people over 75 years of age	8 million
Number of people over age of 75 years after half century	14.5 million
Number of people over age 80 years	5 million
Number of people over age 80 years after half century	12 million
Expected maximum human life span	120-125 years





## PRACTICE EXERCISE

 35 mins  
Time Yourself

1. **Growth process is**
  - (a) Irreversible
  - (b) Reversible
  - (c) Sometimes reversible sometimes irreversible
  - (d) Temporary
2. **A plant has a growth pattern called**
  - (a) Closed growth
  - (b) Open growth
  - (c) In between the two
  - (d) None of these
3. **Speed of growth is**
  - (a) Rapid throughout
  - (b) Slow throughout
  - (c) First slow then rapid then slow again
  - (d) First rapid then slow
4. **Meristems are group of cells that**
  - (a) Allow the surrounding region to divide
  - (b) Provide nutrition
  - (c) Help in movement
  - (d) Retain the potential to divide
5. **Higher plants grow through**
  - (a) Growing points
  - (b) Whole plant body is capable of growing
  - (c) Only roots grow
  - (d) None of these
6. **Meristems are of**
  - (a) Two types
  - (b) Three types
  - (c) Four types
  - (d) Five types
7. **Apical meristems are located at**
  - (a) Tips of leaves
  - (b) Tips of flowers
  - (c) Tips of roots and stems
  - (d) Tips of roots only
8. **Function of intercalary meristems is**
  - (a) Increase in length
  - (b) Increase in diameter
  - (c) Production of leaves and flowers
  - (d) None of these
9. **Lateral meristems are present in**
  - (a) All plants
  - (b) Gymnosperms and dicots
  - (c) Monocots
  - (d) In aquatic plants only
10. **Intercalary meristems are of**
  - (a) Permanent nature
  - (b) Temporary nature
  - (c) Some are permanent some temporary
  - (d) None of these
11. **Determinate growth is**
  - (a) Growing continuously
  - (b) Fluctuating growth
  - (c) Primary growth
  - (d) Grow to certain size and then stop
12. **Vegetative roots and shoots grow by**
  - (a) Determinate growth
  - (b) Primary growth only
  - (c) Indeterminate growth
  - (d) None of these
13. **In plants growth is of**
  - (a) Four types
  - (b) Five types
  - (c) One type
  - (d) Two types
14. **Secondary growth is actually**
  - (a) Extension of plant body
  - (b) Increase in thickness
  - (c) Production of leaves and flowers
  - (d) None of these





15. Cambium are examples of
  - (a) Apical meristems
  - (b) Intercalary meristems
  - (c) Lateral meristems
  - (d) None of these
16. Growth of multicellular plants occur in
  - (a) Two phases
  - (b) Three phases
  - (c) Five phases
  - (d) Four phases
17. In multicellular plants cell division occur by
  - (a) Binary fission
  - (b) Conjugation
  - (c) Meiosis
  - (d) Mitosis
18. Cells elongate by
  - (a) Mitosis
  - (b) Uptake of water
  - (c) Stretching
  - (d) Formation of cell wall
19. Plasticity of cell wall increases during
  - (a) Cell maturation
  - (b) Cell elongation
  - (c) Cell differentiation
  - (d) Cell division
20. Cells of fibers and tracheids elongate during
  - (a) Phase of cell division
  - (b) Phase of cell elongation
  - (c) Phase of cell maturation
  - (d) Phase of cell differentiation
21. During cell differentiation
  - (a) Walls of cells become thick
  - (b) Walls of cells become pitted
  - (c) Both of these
  - (d) None of these
22. Maximum optimum temperature for growth of plants is
  - (a) 30-40 degree C
  - (b) 25-30 degree C
  - (c) 10-20 degree C
  - (d) 20-40 degree C
23. Which one is incorrect
  - (a) Red light favours elongation of cells
  - (b) Blue light retards cell enlargement
  - (c) UV rays retards cell elongation
  - (d) UV rays retard cell division
24. Light duration plays a role in inducing or suppressing flowering, phenomenon is called
  - (a) Photosynthesis
  - (b) Photoperiodism
  - (c) Phototropism
  - (d) Photogenetics
25. Root primordial develop from
  - (a) Apical meristems
  - (b) Intercalary meristems
  - (c) Pericycle
  - (d) Epidermis
26. Growth of apical buds suppressing lower axillary buds is
  - (a) Lateral dominance
  - (b) Compensatory dominance
  - (c) Apical dominance
  - (d) Both a and b
27. In chicks fertilization is
  - (a) Internal
  - (b) External
  - (c) Both a and b
  - (d) None of these
28. Incubation temperature for chick is
  - (a) 20-30 degree C
  - (b) 40-45 degree C
  - (c) 36-38 degree C
  - (d) 25-35 degree C
29. After providing 36-38°C temperature, chick's egg is hatched on
  - (a) 20<sup>th</sup> day
  - (b) 25<sup>th</sup> day
  - (c) 23<sup>rd</sup> day
  - (d) 21<sup>st</sup> day



30. Which one is incorrect?  
(a) Epiblast is presumptive ectoderm and mesoderm  
(b) Hypoblast is presumptive endoderm  
(c) Hypoblast is presumptive mesoderm  
(d) Upper layer of cells in blastoderm is epiblast
31. Peripheral part of blastoderm making contact with yolk is called  
(a) Area pellucida (b) Area opaca  
(c) Blastocoel (d) Area plana
32. Cavity formed between somatic and splanchnic mesoderm is called  
(a) Gastrocoele (b) Blastocoele  
(c) Coelom (d) Neurocoele
33. Mechanism of development was explained by  
(a) Hans Dietrich (b) Spemann  
(c) Both a and b (d) Haemmerling
34. Which statement is correct about gray crescent?  
(a) A pigmented area that appears at time of fertilization  
(b) A pigment free area that disappears at the time of fertilization  
(c) A hyperpigmented area that is present in the embryo  
(d) A pigment free area that appears at time of fertilization
35. Which statement is incorrect?  
(a) Fertilized egg of an ascidian contains cytoplasm of four colours  
(b) Yellow cytoplasm gives rise to gut  
(c) Grey equatorial cytoplasm gives rise to notochord.  
(d) Grey vegetal cytoplasm gives rise to gut
36. *Acetabularia crenulata* has  
(a) Irregular shaped cap (b) Regular shaped cap  
(c) Irregular while young and regular while adult (d) No cap
37. Which statement is correct?  
(a) Ectodermal cells have effect on mesodermal cells to induce differentiation  
(b) Mesodermal cells stimulate ectodermal cells to form nervous system  
(c) Endodermal cells stimulate ectodermal cells  
(d) All are correct
38. Negative physiological changes in our body is called  
(a) Teratology (b) Aging  
(c) Regeneration (d) Embryonic induction
39. Study of aging is  
(a) Teratology (b) Embryology  
(c) Gerontology (d) Pathology
40. The ability to regain or recover the lost or injured part of body is  
(a) Aging (b) Regeneration  
(c) Abnormal development (d) Primary induction
41. Among invertebrates who possess great power of regeneration  
(a) Arthropods (b) Molluscs  
(c) Sponges (d) Nematodes
42. Which statement is incorrect?  
(a) Earthworm can regenerate its head (b) Salamander can regenerate its limbs  
(c) Lizard can regenerate its head (d) Man can regenerate his skin



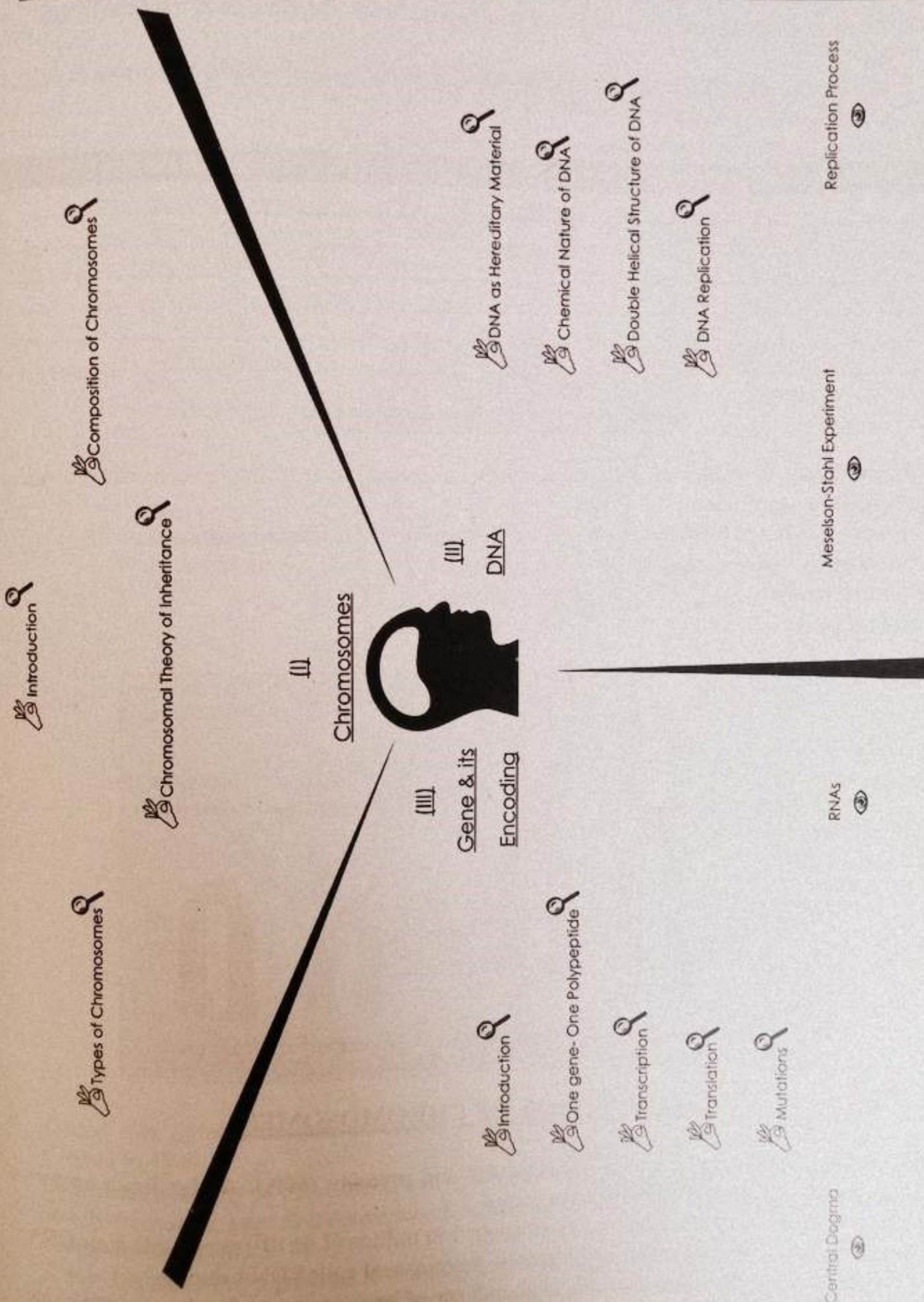


43. Growth is basically an increase in  
(a) Number of cells  
(b) Size of cells  
(c) Both of these  
(d) None of these
44. The stage of rapid cell division just after fertilization is  
(a) Organogenesis  
(b) Cleavage  
(c) Gastrulation  
(d) Growth
45. The German scientist Spemann worked on differentiation in  
(a) 1924  
(b) 1929  
(c) 1915  
(d) 1940
46. Inducer substances are produced by  
(a) Notochord  
(b) Somite  
(c) Archenteron  
(d) Coelom
47. What is the feature of cells in gastrulation?  
(a) Division  
(b) Migration  
(c) Differentiation  
(d) All of these
48. Vertebral column is formed from  
(a) Ectoderm  
(b) Endoderm  
(c) Mesoderm  
(d) None of these
49. Liver and pancreas arise from  
(a) Foregut  
(b) Midgut  
(c) Hindgut  
(d) None of these
50. Hemophilia is  
(a) Excessive bleeding due to defective gene on sex chromosome  
(b) Due to extra sex chromosome  
(c) Due to structural deviation during organogenesis  
(d) Due to nutritional deficiencies



# Chapter 20

## CHROMOSOME & DNA





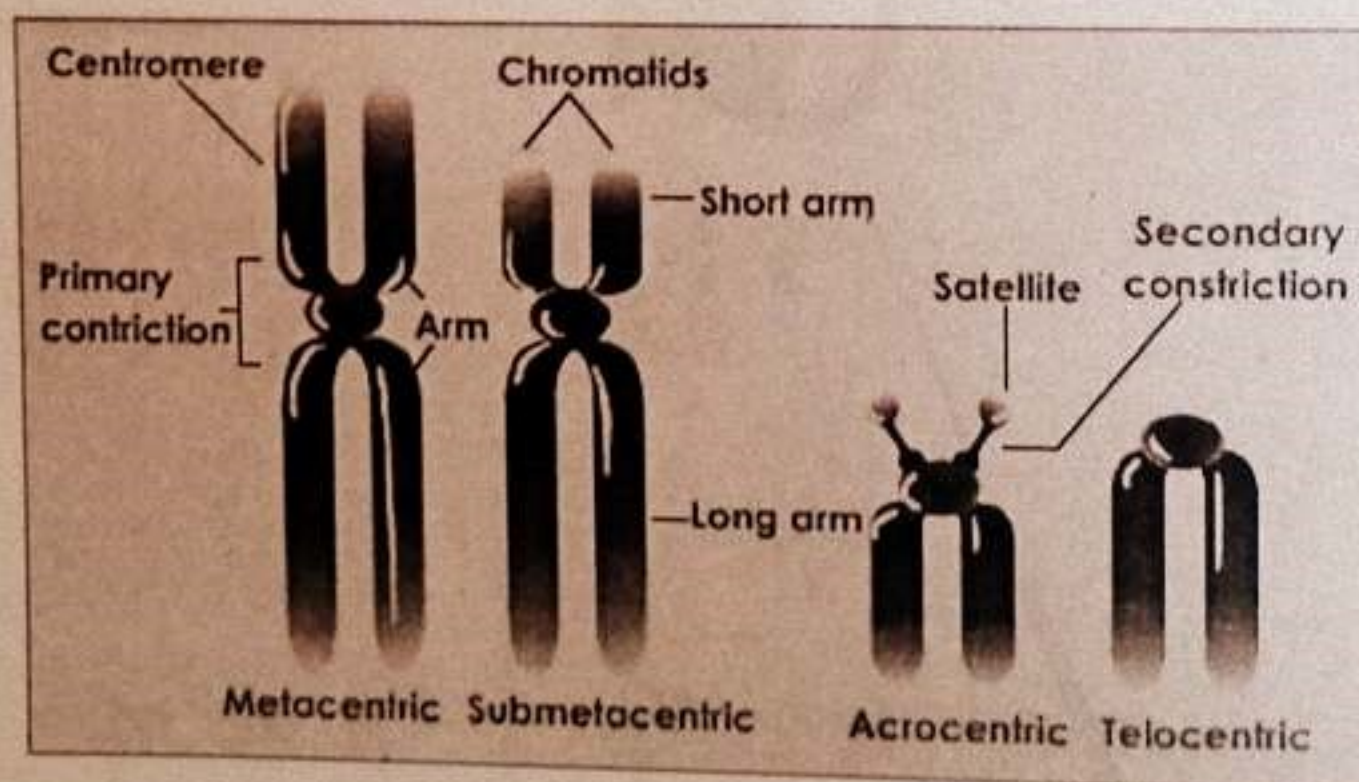
### CONCEPT OF CHROMOSOMES

- **Chromosomes** are thread like structures that appear inside the nucleus at the time of cell division.
- Chromosomes were first observed by the German embryologist *Walther Fleming* in 1882, in cells of salamander larvae
- **Human cells** have 46 chromosomes, consisting of 23 pairs.

ORGANISM	NO. OF CHROMOSOMES
Mosquito	6
Honeybee	32
Corn	20
Sugarcane	80
Frog	26
Mouse	40

### TYPES OF CHROMOSOMES

- Chromosome is made of two **chromatids**, a **centromere** (primary constriction) and a **secondary constriction**
- **Karyotype** is the particular array of chromosomes that an individual possesses.
- **Telocentric and acrocentric** → I shaped
- **Sub metacentric** → j shaped
- **Metacentric** → v shaped

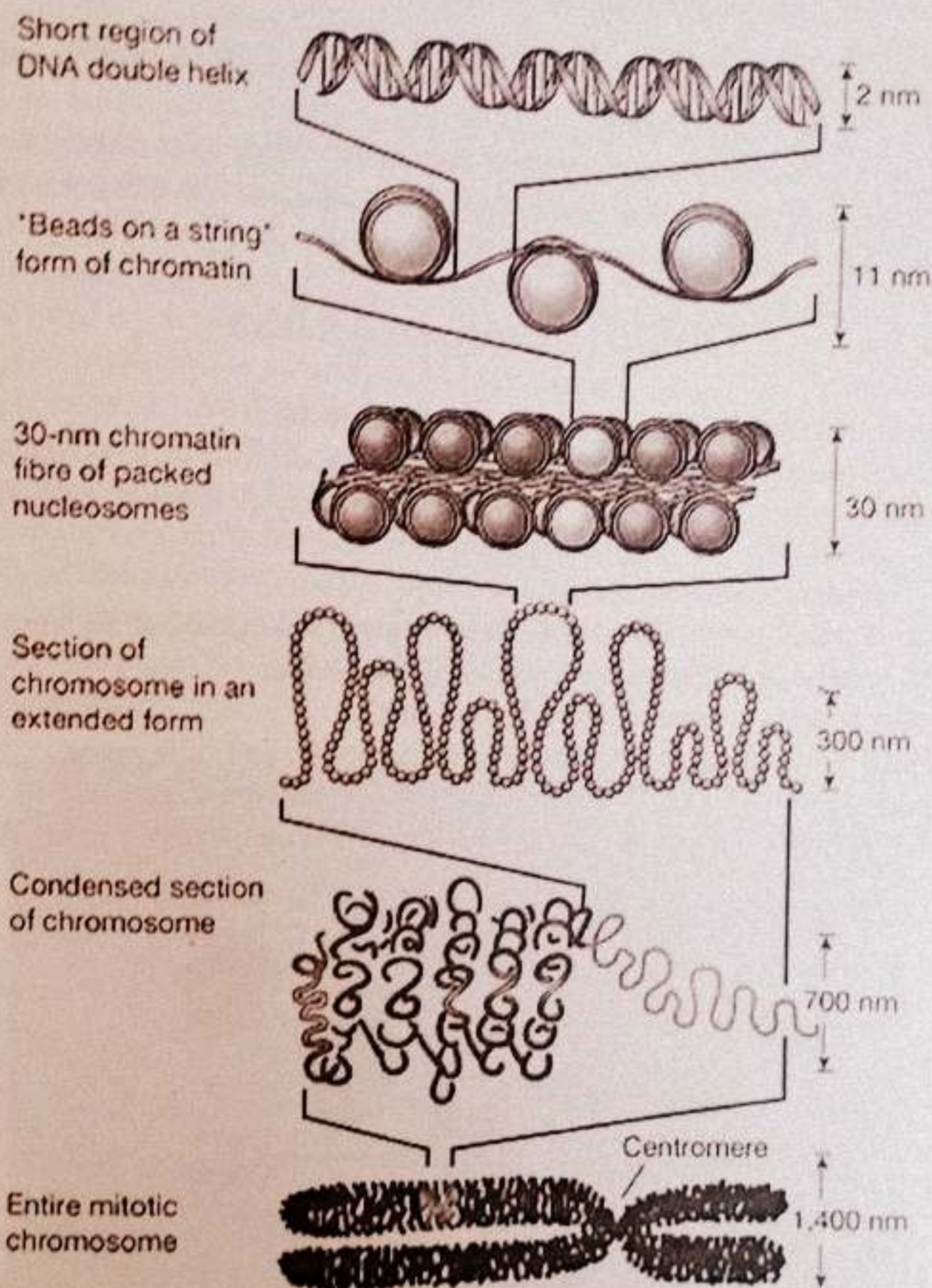


### COMPOSITION OF CHROMOSOMES

- Chromosomes are composed of **DNA (40%)** and **proteins (60%)**. A significant amount of RNA is also associated with chromosomes.
- A **typical human chromosome** contains about 140 million ( $1.4 \times 10^8$ ) nucleotide in its DNA.
- A **nucleosome** is composed of eight histone proteins and coiled DNA duplex.
- **Histones** are positively charged due to abundance of basic amino acids, arginine and lysine.



- Highly condensed portions of the chromatin are called *heterochromatin*.
- Euchromatin* is condensed only during cell division and at other times it is in open configuration and its genes can be expressed.



### THE CHROMOSOMAL THEORY OF INHERITANCE

- Central role of chromosome in heredity was first suggested by German geneticist *Karl Correns* in 1900.
- Chromosomal theory of inheritance was first formulated by American *Walter Sutton* in 1902.
- Sex chromosomes were first discovered by *Thomas Hunt Morgan* in 1910, studying fruit fly, *Drosophila melanogaster*.
- A trait determined by a gene on X chromosome is called *sex linked trait*.

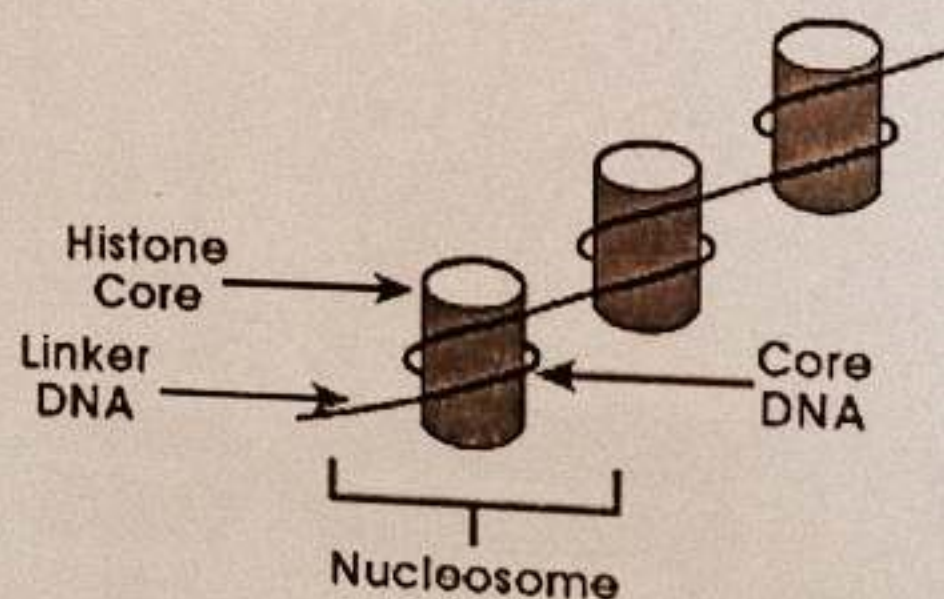


DNA AS HEREDITARY MATERIAL

- First evidence of hereditary nature of DNA was provided by a British microbiologist **Frederick Griffith**.
- **Transformation** is the transfer of genetic material from one cell to another and can alter the genetic make up of the recipient cell.
- Avery, Mcleod and McCarty experimentally proved that DNA is heredity material.
- Harshay & Chase provided final evidence about DNA as heredity material by using radioisotopes  $P^{32}$  &  $S^{35}$  for DNA and proteins respectively.

CHEMICAL NATURE OF DNA

- German chemist **Friedrich Miescher** discovered DNA in 1869.
- Basic structure of nucleic acids was determined by the biochemist **P.A Levene** in 1920.
- DNA contains 3 main components i.e. phosphate groups, 5 carbon sugars, purines and pyrimidines
- **Purines** → adenine and guanine
- **Pyrimidines** → thymine and cytosine, RNA contains uracil instead of thymine
- DNA and RNA made up of repeating units called **nucleotide**.
- **Phosphodiester bond** is present between 2 nucleotides
- **Erwin Chargaff** showed that the amount of adenine = amount of thymine  
Amount of guanine = amount of cytosine
- British chemist **Rosalind Franklin** described X-ray diffraction analysis of DNA.

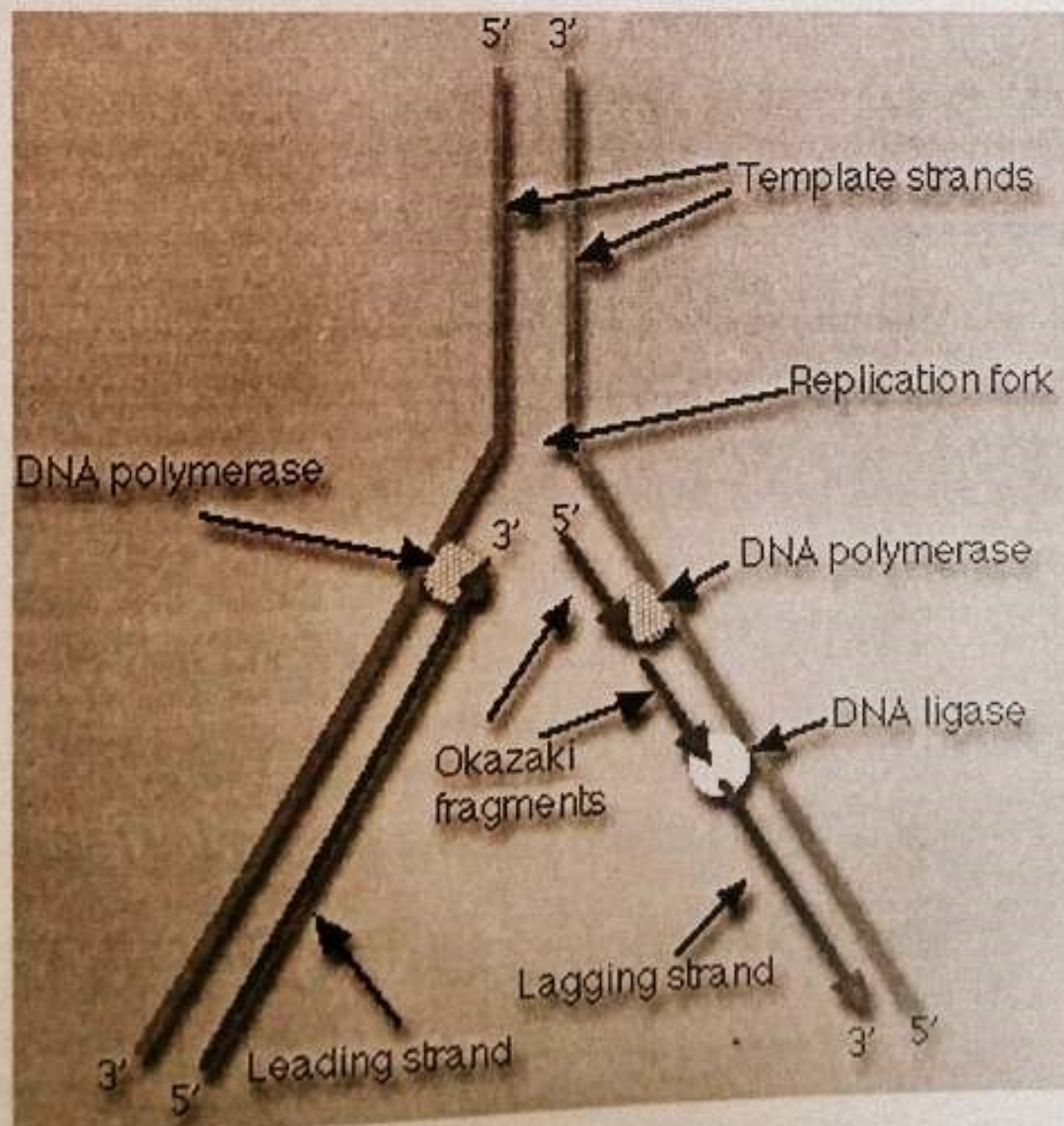
WATSON AND CRICK'S MODEL OF DNA

- According to **Franklin and Wilkin**, DNA has a helix shape with a diameter of 2nm and a complete helical turn of 3.4 nm.
- **Hydrogen bonds** exist between the bases in a base pair.
- Adenine forms two hydrogen bonds with thymine and guanine forms three bonds with cytosine



DNA REPLICATION

- Semi-conservative replication was confirmed by *Meselson and Stahl*.
- In *Semi conservative replication*, the sequence of the original duplex is conserved after one round of replication, the duplex itself is not
- According to *conservative model*, parental double helix would remain intact and generate DNA copies consisting of entirely new molecules
- According to *dispersive model*, parental DNA would become completely dispersed and each strand of all daughter molecules would be a mixture of old and new
- *DNA polymerases* catalyze addition of nucleotides to the complementary strand of DNA. They are of three types I, II and III in bacteria
- The true E.coli replicating enzyme is DNA polymerase III
- *Rate of replication* is 1000 nucleotides / sec
- *Primase* constructs an RNA primer, a sequence of about 10 RNA nucleotides complementary to the parent DNA template
- Replication always proceeds from 5' → 3' direction on a growing DNA strand
- *Leading strand* elongates towards the replication fork.
- *Lagging strand* elongates away from replication fork.
- *Okazaki fragments* are 100-200 nucleotides long in eukaryotes and 1000-2000 nucleotides long in prokaryotes.







1. \_\_\_\_\_ are thread like structures that appear inside the nucleus at the time of cell division.
2. A \_\_\_\_\_ is composed of eight histone proteins and coiled DNA duplex.
3. \_\_\_\_\_ is the transfer of genetic material from one cell to another and can alter the genetic make up of the recipient cell.
4. British chemist \_\_\_\_\_ described X-ray diffraction analysis of DNA.
5. \_\_\_\_\_ elongates towards the replication fork during DNA replication.
6. \_\_\_\_\_ bonds exist between the bases in a base pair.

### CONCEPT OF GENE

- **Archibald Garrod** and **William Bateson** worked on heredity diseases.
- In **alkaptonuria**, patients produce urine that contains homogentisic acid, which on oxidation turns urine black. In normal individuals, it is broken down inside the body through enzyme.
- **George Beadle** and **Edward Tatum** worked on neurospora and developed one gene one enzyme hypothesis.
- Genes produce their effects by specifying structure of enzymes and 1 gene encodes structure of 1 enzyme so **1 gene 1 enzyme** relationship but as enzymes are polypeptide subunits so **1 gene 1 polypeptide** relation ship

### DNA ENCODES PROTEIN STRUCTURE

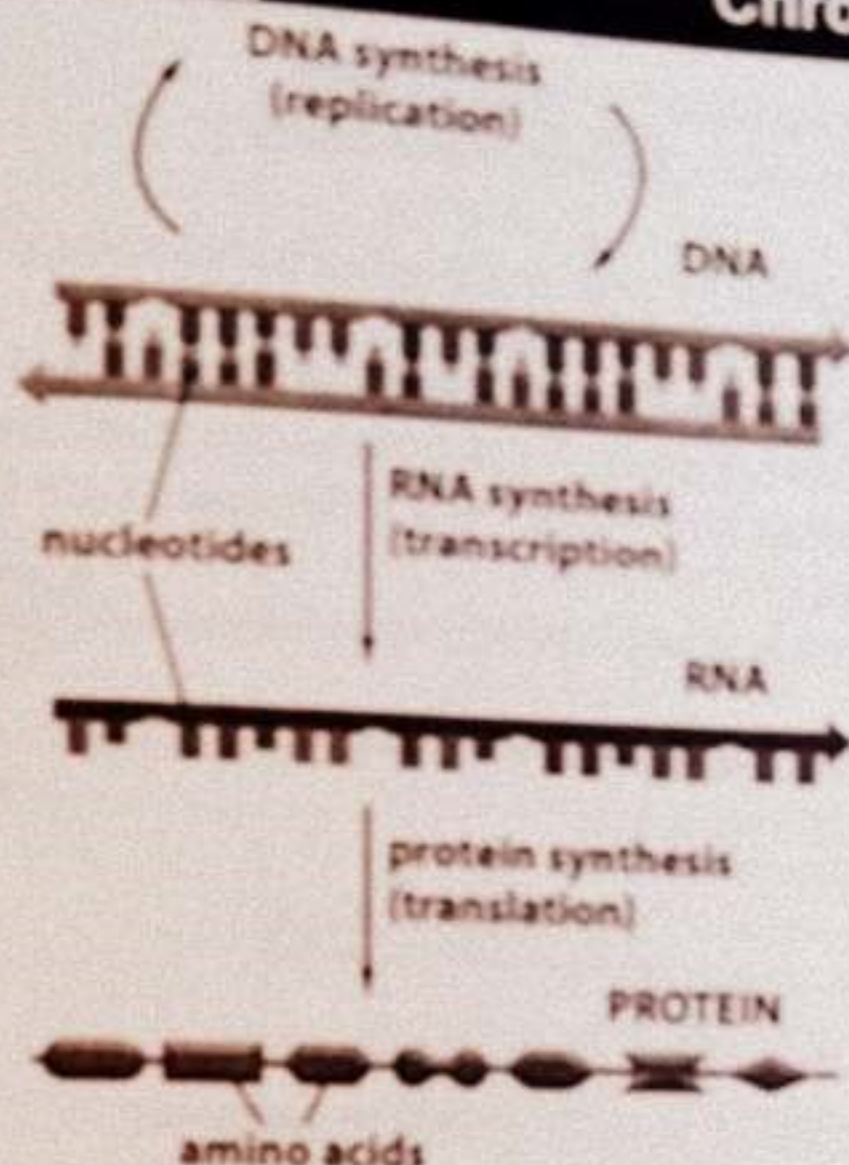
- **Frederick Sanger** described the complete sequence of amino acids of insulin.
- **Vernon Ingram** in 1956 discovered the molecular basis of sickle cell anemia.
- The sequence of nucleotides that determines the amino acid sequence of a protein is called a gene.

### CELLS USE RNA TO MAKE PROTEIN

- Basic mechanism of reading and expressing genes is in all organisms, is called as **central dogma**.
- Transfer of information from DNA (central dogma) to mRNA is called **transcription** (1st step of central dogma).
- Transfer of information from RNA to proteins is called **translation** (2<sup>nd</sup> step of central dogma).

Answers: (1) Chromosomes (2) Nucleosome (3) Transformation (4) Rosalind Franklin (5) Leading Strand (6) Hydrogen





### Types of RNA

- There are *three types of RNA* : rRNA , tRNA , mRNA.
- Human cells contain about 45 different kinds of tRNA molecules.

### TRANSCRIPTION

- **Transcription** is the process by which an RNA copy of the DNA sequence encoding the gene is produced with the help of an enzyme , *RNA polymerase*.
- RNA polymerase transcribes only one strand of DNA, which is called *template or antisense strand*. Other strand is called *coding strand or sense strand*.
- RNA polymerase enzyme synthesizes RNA from 5 to 3.
- There is only one type of RNA in prokaryotes which is responsible for the synthesis of all three types of RNAs.
- In **prokaryotes** only one type of RNA polymerase synthesize all 3 types of RNA.
- In eukaryotes, *RNA polymerase I* synthesizes rRNA, *RNA polymerase II* mRNA and *RNA polymerase III* synthesizes tRNA.
- Transcription starts from promoter on DNA template strand.
- In prokaryotes within promoter there are *two binding sites* TTGACA also called -35 sequence and TATAAT sequence also called -10 sequence. In eukaryotes these are -25 and -70 sites.
- In **bacteria** newly synthesized mRNA is directly released into the cytoplasm when it is converted into polypeptide chain, while in **eukaryotes** it has to travel a large distance from inside the nucleus to ribosomes outside in cytoplasm.
- In eukaryotes mRNA is protected from action of nucleases and phosphatases by addition of 7-methyl GTP as cap at 5 end while poly A tail at 3 end.



GENETIC CODE

- **Genetic code** is a combination of three nucleotides, which specify a particular amino acid so it is a **triplet code**.
- **Marshal Nirenberg, Philip Leader and Har Gobind Khorana** tested all 64 codons by making artificial mRNAs or amino-acyl tRNA complexes in cell free system.
- Out of 64 codons, 3 codons UAA, UAG and UGA do not code for any amino acid and so known as **nonsense codon**.
- Every gene starts with initiation codon AUG, which encodes the amino acid methionine. This is called **start codon**.
- **Genetic code is not quite universal** because UGA codon which is normally a stop codon but in mitochondria appears as tryptophan.

TRANSLATION

- Three nucleotide sequence on tRNA is called **anticodon**.
- Ribosome and aminoacyl-tRNA is called **initiation complex**.
- Particular tRNA molecule becomes attached to specific amino acids through the action of activating enzymes called **aminoacyl-tRNA synthetase**.
- P (peptidyl site) is involved in peptide bond formation, A (Aminoacyl site) for successive aminoacyl-tRNA and E (Exit site) to eject hollow tRNA.
- Initiation factors, elongation factors & termination factors are the main components/ enzymes involved in process of translation.
- Translation starts at start codon (AUG) and ends at stop codon (UAA, UAG, UGA).

MUTATIONS

- Mutations are changes in the DNA occurring either due to mistake in replication or damage to the genetic message.
- Two types of mutations are chromosomal aberrations and point mutations
- **Chromosomal aberrations** are changes involving presence of an extra chromosome or loss of a chromosome from diploid number of chromosome leading to syndromes like Down's syndrome, Klinefelter's syndrome etc.
- **Point mutations** are changes which affect the message itself producing alterations in the sequence of DNA nucleotide e.g sickle cell anemia and phenylketonuria
- In **sickle cell anemia**, a point mutation leads to a change of amino acid glutamic acid into valine at position 6 from N terminal end in Hb-beta chain
- In **phenylketonuria**, phenylalanine is not degraded because of defective enzyme phenylalanine hydroxylase. Phenylalanine accumulates in brain cells causing mental retardation.





1. In alkaptonuria, patients produce urine that contains \_\_\_\_\_.
2. \_\_\_\_\_ in 1956 discovered the molecular basis of sickle cell anemia.
3. Basic mechanism of reading and expressing genes in all organisms, is called as \_\_\_\_\_.
4. Human cells contain about \_\_\_\_\_ different kinds of tRNA molecules.
5. Transcription starts from \_\_\_\_\_ on DNA template strand.
6. Every gene starts with initiation codon AUG, which encodes the amino acid \_\_\_\_\_.
7. \_\_\_\_\_ site on ribosome is involved in peptide bond formation.
8. \_\_\_\_\_ aberrations are changes involving presence of an extra chromosome or loss of a chromosome.





## VALUES

Property	Value
Number of chromosomes in <i>Penicillium</i>	1 pair
Number of chromosomes in Fern	Over 500 pairs
Number of chromosomes in mosquito	6
Number of chromosomes in honey bee	32
Number of chromosomes in corn	20
Number of chromosomes in sugarcane	80
Number of chromosomes in frog	26
Number of chromosomes in mouse	40
Number of chromosomes in human cell	46 (23 pairs)
Amount of DNA in chromosome	40%
Amount of protein in DNA	60%
Number of nucleotides in atypical human chromosome	140 million ( $1.4 \times 10^8$ )
Amount of information in one chromosome can fill	200 printed books of hundred pages with each page having 500 words on it. Each nucleotide representing a word.
Length of straight DNA from a single chromosome	5 centimeter
Each nucleosome	2 turns of DNA duplex, 200 nucleotides, 8 histones
Diameter of DNA helix	2 nm
Length of complete helical turn of DNA	3.4 nm
Distance between two base pairs in DNA	0.34 nm
Number of DNA polymerase	3
DNA polymerase III is larger than I by	3 times
Rate of addition of nucleotides by DNA polymerase III	1000 nucleotides/ second
Number of nucleotides in Okazaki fragments in eukaryotes	100-200
Number of nucleotides in Okazaki fragments of prokaryotes	1000-2000
Number of tRNA in human cell	45
TTGACA in prokaryote	-35 sequence
TTGACA in eukaryote	-25 sequence
TATAAT in prokaryote	-10 sequence
TATAAT in eukaryote	-70 sequence
Number of nucleotides in single genetic code	3
Number of total codons	64
Number of nonsense codons	3
Number of aminoacyl-tRNA synthetase	20
Length of DNA in all cells of adult human	100 billion kilometers (60 times the distance from Earth to Jupiter)
Position for point mutation for sickle cell Hb	6



## PRACTICE EXERCISE



1. Which is incorrect?
  - (a) Chromosomes 1<sup>st</sup> observed by Walther Fleming
  - (b) Chromosomal theory of inheritance 1<sup>st</sup> formulated by Walter Sutton
  - (c) 1<sup>st</sup> evidence of hereditary nature of DNA provided by Friedrich Miescher
  - (d) Sex chromosomes discovered by Thomas Hunt Morgan
2. Chromosome is made of
  - (a) 2 chromatids + 1 centromere + secondary constriction
  - (b) 1 chromatid + 1 centromere + primary constriction
  - (c) 2 chromatids + 1 centromere + primary constriction
  - (d) 2 chromatids + 2 centromere + secondary constriction
3. Chromosomes are composed of
 

(a) 40% protein and 60% DNA	(b) 50% protein and 50% DNA
(c) 70% protein and 30% DNA	(d) 60% protein and 40% DNA
4. A typical human chromosome contains \_\_\_\_\_ nucleotides in its DNA
 

(a) 240 million	(b) 140 million
(c) 150 million	(d) 160 million
5. Histones have abundance of amino acids
 

(a) Valine and lysine	(b) Arginine and lysine
(c) Valine and arginine	(d) Histidine and threonine
6. A portion of chromatin that is condensed only during cell division is
 

(a) Euchromatin	(b) Heterochromatin
(c) Biochromatin	(d) Nucleochromatin
7. Transfer of genetic material from one cell to another that can alter the genetic makeup of recipient cell is called
 

(a) Mutation	(b) Transuction
(c) Replication	(d) Variation
8. Who discovered DNA?
 

(a) P.A. Levene	(b) Frederick Griffith
(c) Friedrich Miescher	(d) Rosalind Franklin
9. DNA contains
 

(a) Purines (A and G) pyrimidines (U and C)	(b) Purines (T and C) pyrimidines (A and G)
(c) Purines (A and C) pyrimidines (U and G)	(d) Purines (A and G) pyrimidines (T and C)
10. In DNA
 

(a) A forms two bonds with T	(b) G forms three bonds with C
(c) A forms three bonds with T	(d) Both a and b
11. DNA has a helical shape with the diameter of
 

(a) 3 nm	(b) 4 nm
(c) 2 nm	(d) 5 nm





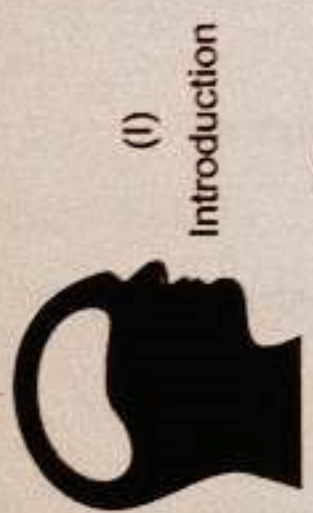
12. In semi-conservative replication  
 (a) Sequence of original duplex is conserved after one round of replication  
 (b) Generate DNA copies of entirely new molecules  
 (c) Parental DNA become completely dispersed  
 (d) Each strand of daughter molecules will be a mixture of old and new
13. The true *E. Coli* replicating enzyme is  
 (a) DNA polymerase I  
 (b) DNA polymerase II  
 (c) DNA polymerase III  
 (d) All of these
14. Rate of DNA replication by DNA polymerase is  
 (a) 2000 nucleotides / sec  
 (b) 1000 nucleotides / sec  
 (c) 150 nucleotides / sec  
 (d) 1050 nucleotides / sec
15. Replication always proceeds in a direction  
 (a)  $3' \rightarrow 5'$   
 (b)  $5' \rightarrow 3'$   
 (c) Both directions  
 (d) None of these
16. Which statement is correct?  
 (a) Leading strand elongates away from the replication fork  
 (b) Lagging strand elongates towards the replication fork  
 (c) Lagging strand is constructed discontinuously.  
 (d) Both a and b
17. The length of okazaki fragments in eukaryotes is  
 (a) 150-250 nucleotides long  
 (b) 200-300 nucleotides  
 (c) 1000-2000 nucleotides  
 (d) 100-200 nucleotides
18. In alkaptonuria  
 (a) Patient's urine contains homogentisic acid  
 (b) Urine becomes black  
 (c) Both a and b  
 (d) Urine contains phenylalanine.
19. The sequence of nucleotides that determines the amino acid sequence of a protein is  
 (a) Chromosome  
 (b) DNA  
 (c) RNA  
 (d) Gene
20. Central dogma is  
 (a) Transfer of information from DNA to mRNA  
 (b) Basic mechanism of reading and expressing genes  
 (c) Transfer of information from RNA to proteins  
 (d) Synthesis of all three types of RNA
21. In prokaryotes there are  
 (a) Three types of DNA polymerases  
 (b) One type of RNA polymerase  
 (c) Three types of RNA polymerase  
 (d) Both a and b
22. Human cell contains \_\_\_\_\_ different kinds of tRNA molecules  
 (a) 25  
 (b) 35  
 (c) 45  
 (d) 15
23. In eukaryotes newly synthesized mRNA  
 (a) Travels a large distance from nucleus to cytoplasm  
 (b) Is directly released into the cytoplasm  
 (c) Contains a cap and tail  
 (d) Both a and c
24. Which 3 codons are nonsense codons?  
 (a) UAA, UAU, UUA  
 (b) UGA, UAG, UAA  
 (c) UGG, UGA, UAU  
 (d) UGG, UAA, UAG



25. Methionine is specified by  
 (a) Stop codon  
 (c) Start codon  
 (b) AUG  
 (d) Both b and c
26. In mitochondria UGA is/specifics as  
 (a) Stop codon  
 (c) Initiation codon  
 (b) Tryptophan  
 (d) Methionine
27. Three nucleotide sequence on tRNA that specifies an amino acid is  
 (a) Codon  
 (c) Nonsense codon  
 (b) Anticodon  
 (d) Genetic code
28. Initiation complex in translation is composed of  
 (a) Ribosome and aminoacyl-tRNA  
 (c) tRNA and aminoacyl-tRNA  
 (b) Ribosome and tRNA  
 (d) None of these
29. Examples of chromosomal aberrations are  
 (a) Sickle cell anemia  
 (c) Down's syndrome  
 (b) Phenylketonuria  
 (d) Both a and b
30. Point mutations are represented as  
 (a) Presence of an extra chromosome  
 (c) Alteration in sequence of DNA nucleotide  
 (b) Loss of chromosome  
 (d) Insertions and inversion of genes
31. Strand of DNA which is not transcribed is called  
 (a) Antisense  
 (c) Coding  
 (b) Template  
 (d) None of these
32. Phenylketonuria is due to deficiency of  
 (a) Phenylalanine  
 (c) Phenylene  
 (b) Phenylalanine hydroxylase  
 (d) All of these
33. Molecular basis of sickle cell anaemia was found by  
 (a) F. Sanger  
 (c) Vernone Ingram  
 (b) Beadle and Tatum  
 (d) Mendal
34. Which is incorrect about nucleosome  
 (a) 2 turns of DNA coiled round histones  
 (c) 200 nucleotides in one nucleosome  
 (b) 8 histones as acidic proteins  
 (d) None of these
35. Sex chromosomes were 1<sup>st</sup> discovered in  
 (a) Man  
 (c) Fruitfly  
 (b) Pea plant  
 (d) None of these
36. A sugarcane cell has \_\_\_\_\_ chromosomes.  
 (a) 20  
 (c) 40  
 (b) 32  
 (d) 80
37. Centromere represents  
 (a) Primary constriction  
 (c) Tertiary constriction  
 (b) Secondary constriction  
 (d) Quaternary constriction
38. Which of the following can kill mice if injected separately?  
 (a) Live R type pneumococcus  
 (c) Live S type pneumococcus  
 (b) Heat killed R type pneumococcus  
 (d) Heat killed S type pneumococcus
39. X-Ray diffraction pattern of DNA was prepared by  
 (a) Rosalind Franklin  
 (c) Watson  
 (b) Maurice Wilkins  
 (d) Crick
40. In sickle cell Hb, which chain is affected?  
 (a) Alpha chain  
 (c) Both of these  
 (b) Beta chain  
 (d) None of these



Cell Cycle  
Interphase  
Cell Death



(i) Introduction

(ii) Mitosis

(iii) Meiosis

Meiosis I  
Meiosis II  
Importance  
Meiotic Errors

Karyokinesis  
Cytokinesis  
Importance  
Cancer

Telophase

Anaphase

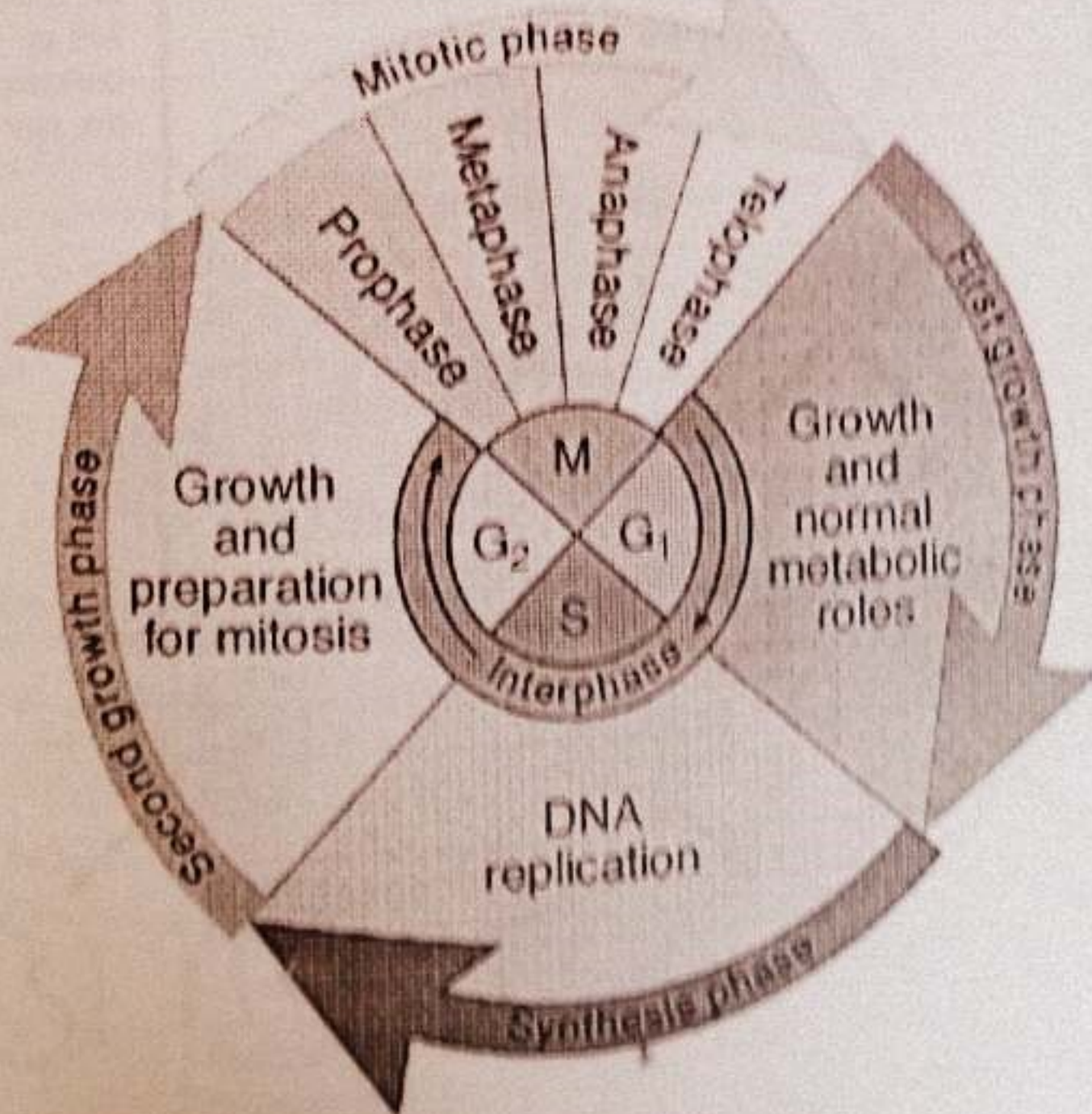
Metaphase

Prophase I

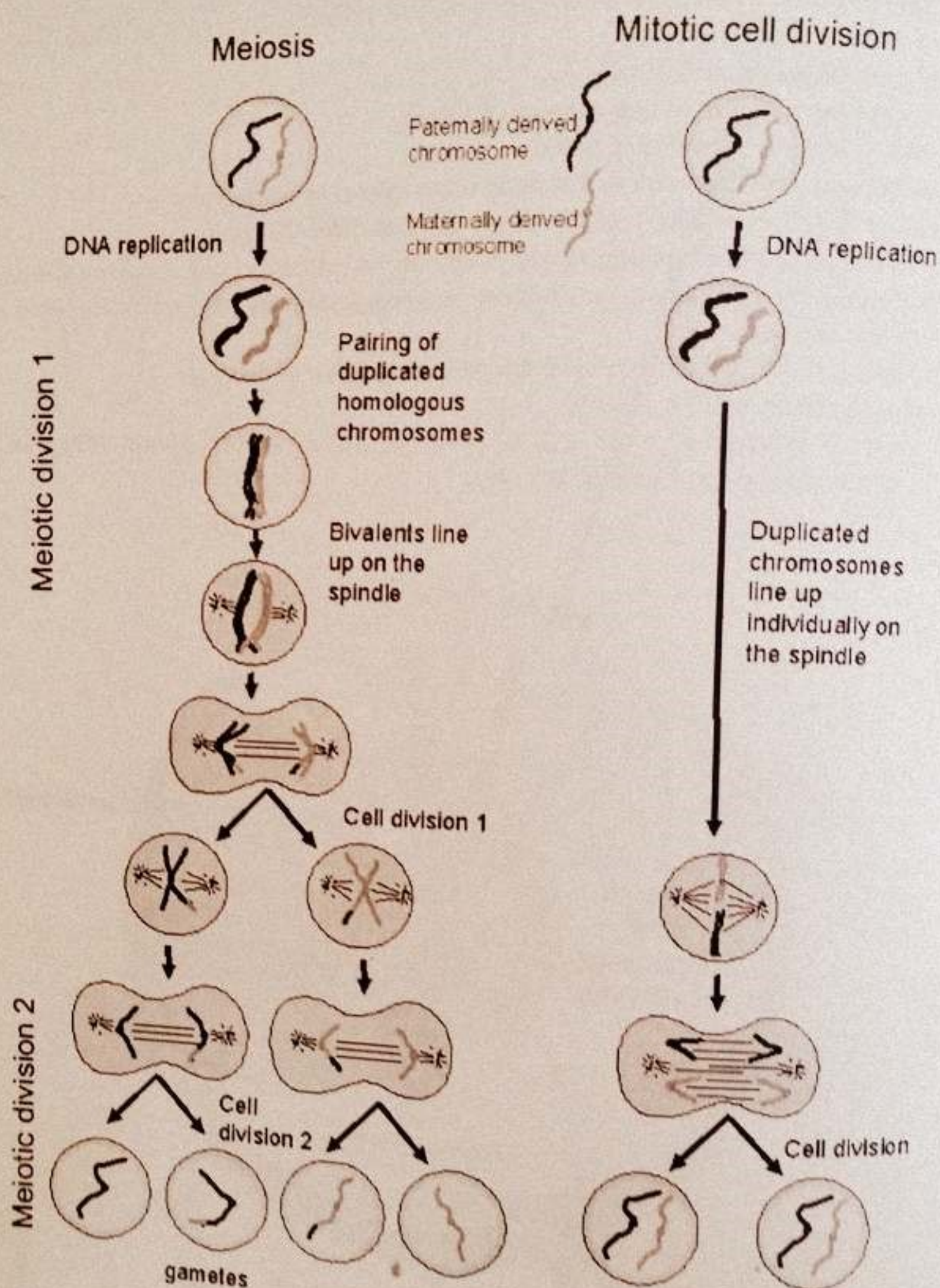
Prophase



- The cell sequence of changes involving period of growth, replication of DNA, followed by cell division is called **cell cycle**.
- There are two phases of cell cycle i.e.
  - i. **Interphase** :- period of non-apparent division
  - ii. **Mitotic phase** :- period of division
- Period between two consecutive divisions is **interphase or resting phase**
- Interphase is further divided into **G<sub>1</sub>-phase, S-phase and G<sub>2</sub>-phase**.
- **G<sub>1</sub>-phase** is period of extensive metabolic activity, cell grows in size, enzymes synthesize etc.
- Some post mitotic cell remain in **G<sub>0</sub>-phase** for considerable duration e.g. neuron cells and cells of lens of eye.
- In **S-phase**, DNA is synthesized and chromosome number is doubled
- **G<sub>2</sub>-phase** prepares cell for division
- In human cell average cell cycle is about 24 hrs, mitosis 30 min, G<sub>1</sub> 9hrs, S 10hrs, G<sub>2</sub> 4-5 hrs
- Full cycle in **yeast** cells is only 90 minutes.







- **Mitosis** ensures same number of chromosomes in daughter cells as that in parent cell.
- Mitosis occurs in **haploid** as well as in **diploid cells**.
- **Karyokinesis** is division of nucleus.
- **Cytokinesis** is division of whole cell.
- **Microtubules** are composed of protein tubulin and traces of RNA.



- Three sets of microtubules originate from each pair of centrioles
- Polar and kinetochore microtubules collectively constitute *spindles*.
- *Mitotic apparatus* is formed by aster and spindle. It is larger than nucleus.

PHASE	EVENTS
Prophase	<ul style="list-style-type: none"> <li>• Centrioles divide and start moving to the opposite poles.</li> <li>• Mitotic apparatus is formed.</li> <li>• Chromosomes condense as they coil.</li> <li>• Nuclear membrane and nucleoli disappear.</li> </ul>
Metaphase	<ul style="list-style-type: none"> <li>• One spindle fiber from each pole gets attached to centromere of each chromosome.</li> <li>• Chromosomes are arranged at equatorial region of spindle.</li> <li>• Each kinetochore gets 2 fibers 1 from each pole</li> </ul>
Anaphase	<ul style="list-style-type: none"> <li>• Spindle fiber contract and centromere divides.</li> <li>• Each chromatid now called chromosome moves towards opposite pole.</li> </ul>
Telophase	<ul style="list-style-type: none"> <li>• Reverse of prophase.</li> <li>• Chromosomes uncoil</li> <li>• Nuclear membrane is reformed.</li> </ul>

### Importance of Mitosis

- Mitosis is important in asexual reproduction, regeneration, healing of wounds, replacement of older cells, development, growth, tissue culture and cloning.
- Hereditary material is equally distributed in the daughter cell. The genetic information remains unchanged generation after generation, thus continuity of similar information is ensured from parent to daughter cell.

### MITOSIS IN PLANTS AND ANIMALS

FEATURE	PLANTS	ANIMALS
Centriole	Absent	Present
Mitotic apparatus	Spindles	Centriole, asters, spindles
Change in cells shape	No	Yes
Cytokinesis	Outward to inward	Outward to inward
	Inward to outward	Furrowing, cleavage of cell membrane
	Phragmoplast	
Functions	Gamete formation, vegetative propagation, tissue culturing, growth	Asexual reproduction, healing, regeneration, cloning, replacement of worn out and old RBCs, development, growth



CANCER

- **Cancer** is uncontrolled cell division.
- **Tumor** is unwanted clone of cells, which can expand indefinitely.
- Tumors are of **two basic types** i.e. benign and malignant
- **Benign tumors** are localized and not transferred to other parts, cells behave like normal cells and have little deleterious effects
- **Malignant tumors** invade surrounding tissue, divide rapidly and metastasize
- Spread of tumor cells and establishment of secondary areas of growth is called **metastasis**
- Presence of invading cells in an otherwise normal tissue is indication of **malignancy**.
- **Cancer cells** are less differentiated, high nucleus to cytoplasmic ratio, prominent nucleoli and many mitosis



1. Period between two consecutive divisions is \_\_\_\_\_.
2. Full cycle in yeast cells is only \_\_\_\_\_ minutes.
3. \_\_\_\_\_ are composed of protein tubulin and traces of RNA.
4. Chromosomes are arranged at equatorial region of spindle during \_\_\_\_\_ phase of mitosis.
5. \_\_\_\_\_ is reverse of prophase.
6. \_\_\_\_\_ tumors are localized and not transferred to other parts.
7. Presence of invading cells in an otherwise normal tissue is indication of \_\_\_\_\_.

Answers: (1) Interphase (2) 90 (3) Microtubules (4) Metaphase (5) Telophase (6) Benign (7) Malignancy



- In **meiosis**, chromosome number in daughter cells becomes half as compared to parent cell.
- It takes place in diploid cells only. In meiosis only single replication of DNA occurs.
- First meiotic division is the reduction division.

**Prophase I**

It is longest phase of meiosis.

Prophase is further divided into:

Stage	Events
Leptotene	<ul style="list-style-type: none"> <li>• Condensation of chromosomes occurs.</li> <li>• Size of nucleus increases.</li> </ul>
Zygotene	<ul style="list-style-type: none"> <li>• Synapsis starts i.e. pairing of homologous chromosomes.</li> <li>• Each paired but not fused complex structure is called tetrad or bivalent.</li> </ul>
Pachytene	<ul style="list-style-type: none"> <li>• Pairing is completed.</li> <li>• Each bivalent has 4 chromatids.</li> <li>• Non sister chromatids of homologous chromosomes exchange their segments due to chiasmata formation.</li> </ul>
Diplotene	<ul style="list-style-type: none"> <li>• Paired chromosomes repel each other and begin to separate.</li> <li>• Homologous chromosomes remain united by chiasmata.</li> <li>• Each bivalent has one such point.</li> </ul>
Diakinesis	<ul style="list-style-type: none"> <li>• Condensation of chromosome completes.</li> <li>• Homologous chromosomes united at ends.</li> <li>• Nucleoli disappear.</li> </ul>

**Metaphase I**

- Each bivalent i.e. pair of homologous chromosome is arranged on equator of cell.
- Bivalent is still attached at chiasmata.
- Arrangement of bivalent is totally random so it will lead to further genetic variation.

**Anaphase I**

- Spindle fibers contract and pull the bivalent apart.
- Chromosomes move towards opposite poles and chromatids are not separated.

**Telophase I**

- Nuclear membrane is reformed. Cytokinesis occurs.
- Two daughter cells are produced each with haploid (n) chromosome.

**Importance of Meiosis**

- Meiosis maintains chromosome number constant generation after generation.
- *Crossing over and random assortment of chromosomes* are two significant happenings of meiosis.





- Both these phenomenon cause variations and modifications in the genome which is the basis for evolution

### MITOSIS AND MEIOSIS

FEATURE	MITOSIS	MEIOSIS
Definition	Chromosome number is same in daughter cells as in parent cell	Chromosomes number is reduced to half
Constancy of chromosome no.	Cell to cell	Generation to generation
Pairing	No	Yes
Crossing over	No	Yes
Variations	No	Yes
Evolution	No	Yes
Cells involved	Both diploid and haploid	Only diploid
	Somatic cells	Reproductive cells
Reproduction	Asexual	Sexual
Divisions	Single	Two (I & II)
Interphase	Long	Short
G <sub>2</sub>	Yes	No
Daughter cells	2	4
Replication of chromosome	Yes	No
Role in plants	Gamete formation, propagation	Spore formation
Role in animals	Asexual reproduction, development, growth	Gamete formation

### NON-DISJUNCTION

- Inability of chromosomes to separate after crossing over during anaphase and telophase of meiosis is called non-disjunction.

FEATURE	DOWN'S SYNDROME	KLINEFILTER'S SYNDROME	TURNER'S SYNDROME
Chromosome	21st autosome	Sex chromosome	Sex chromosomes
Chr. No.	Additional $2n+1$ 47	Additional $2n+1$ 47	Missing $2n-1$ 45
Gamete	24	24	22
Gamete involved	Ova	Sperm	Egg
Chances	Teen age mother = 1/1000 40 years = 1/100 45 years = 3/100	1/1500	1/61000
Abortuses	1/40	0	1/18
Affected Individuals	Flat, broad face, squint eyes with skin folded in	Phenotypically male with enlarged breasts tendency	Often do not survive pregnancy.



## Chapter 21

### Cell Cycle

	the inner corner, protruding tongue, mental retardation, defective development of CNS	to tallness, obesity, small testes, no sperm at ejaculation, under development of secondary sex characters.	aborted mostly, if survived have female appearance, short stature, webbed neck no ovaries, complete absences of germ cells.
Chromosomal relation	45 autosome+XY	44 autosome+XXY=47	44 autosome+Y

### APOPTOSIS AND NECROSIS

- **Apoptosis** (Greek word meaning dropping off or falling off) is internal programme of events and sequence of morphological changes by which cell commits suicide.
- Cell death due to tissue damage is called **necrosis**.
- Necrosis damages neighbouring cells and cause inflammation

FEATURE	APOPTOSIS	NECROSIS
Definition	Morphological changes leading to cell death	Tissue damage
Other name	Cell suicide	Cell murder
Role	Beneficial	Harmful
Release of intracellular constituents	No	Yes



1. Synapsis occurs during \_\_\_\_\_ of prophase I.
2. \_\_\_\_\_ is the longest phase of meiosis.
3. Inability of chromosomes to separate after crossing over during anaphase and telophase of meiosis is called \_\_\_\_\_.
4. Cell death due to tissue damage is called \_\_\_\_\_.
5. Internal programme of events and sequence of morphological changes by which cell commits suicide is called \_\_\_\_\_.

Answers: (1) Zygotene (2) Prophase I (3) Non-dysjunction (4) Necrosis (5) Apoptosis





## VALUES

Property	Value
Average cell cycle in man	24 hours
Length of mitosis in man	30 minutes
Length of G1 phase in man	9 hours
Length of S phase in man	10 hours
Length of G2 phase in man	4.5 hours
Average cell cycle in yeast cell	90 minutes
Length of chromosome during prophase	0.25 $\mu\text{m}$ to 50 $\mu\text{m}$
Chromosome involved in Down's syndrome	21 <sup>st</sup>
Number of chromosome in person with Down's syndrome	47 ( $2n + 1$ )
Chances of teenage mother having Down's syndrome child	1 in many thousand
Chances of 40 years old mother having Down's syndrome child	1 in hundred
Chances of 45 years old mother having Down's syndrome child	3 in hundred
Number of chromosome in an individual with Klinefilter's syndrome	47 (44 autosome + XXY)
Number of chromosome in an individual with Turner's syndrome	45 (44 autosome * X)





## PRACTICE EXERCISE



1. Period between two consecutive divisions is called.  
(a) Interphase (b) Resting phase  
(c) Mitotic phase (d) Cell cycle
2. DNA is synthesized and chromosome number is doubled in  
(a) G1 phase (b) S phase  
(c) G2 phase (d) G0 phase
3. In case of neurons, post mitotic cell escapes cell cycle and remain in \_\_\_\_\_ phase without proliferating further  
(a) G0 phase (b) G1 phase  
(c) G2 phase (d) S phase
4. Which statement is incorrect?  
(a) In human, cell cycle is about 24 hrs (b) Mitosis takes 30 min  
(c) G2 5.5 hrs (d) Yeast cell only 90 min
5. Mitosis occurs in  
(a) Diploid cells only (b) Haploid cells only  
(c) Both diploid and haploid cells (d) Monoploid cells
6. Microtubules are composed of  
(a) Actin protein (b) Actin and myosin proteins  
(c) Sphingomyelin and tubulin (d) Tubulin protein and traces of RNA
7. From each pair of centrioles \_\_\_\_\_ sets of microtubules originate  
(a) 2 (b) 3  
(c) 4 (d) 5
8. Mitotic apparatus in animals is formed by  
(a) Aster and spindle (b) Polar and kinetochore microtubules  
(c) Spindle and RNA (d) Spindle only
9. A special area of centromere with specific base arrangement and specific proteins where spindle fibers are attached is called  
(a) Chromatin (b) Aster  
(c) Kinetochore (d) Primary constriction
10. Each kinetochore gets \_\_\_\_\_ fibers in mitosis  
(a) 5 (b) 4  
(c) 3 (d) 2
11. Most critical phase of mitosis is  
(a) Prophase (b) Anaphase  
(c) Metaphase (d) Telophase
12. Reverse of prophase is  
(a) Interphase (b) Metaphase  
(c) Anaphase (d) Telophase
13. In plants mitotic apparatus consists of  
(a) Centriole (b) Centriole and asters  
(c) Centrioles, asters and spindles (d) Spindles only





14. Which statement is not true about phragmoplast?  
 (a) Formed from vesicle originating from Golgi apparatus  
 (b) Present in plants only  
 (c) Formed at the end of anaphase  
 (d) Centre of dividing cell
15. Spread of tumor cells and establishment of secondary areas of growth is  
 (a) Benign tumors  
 (b) Cancer  
 (c) Metastasis  
 (d) Epistasis
16. Which is a feature of malignant tumor?  
 (a) Localized  
 (b) Little deleterious effects  
 (c) Few mitosis  
 (d) Metastasize
17. Feature of cancer cells in common?  
 (a) High nucleus to cytoplasmic ratio  
 (b) Prominent nucleoli  
 (c) Many mitosis  
 (d) All of these
18. Meiosis occur in  
 (a) Diploid cells only  
 (b) Haploid cells only  
 (c) Both diploid and haploid cells  
 (d) Monoploid cells only
19. Meiosis occurs at the time of  
 (a) Gamete formation in animals  
 (b) Spore formation in plants  
 (c) Growth in animals  
 (d) Both a and b
20. Interphase of meiosis lacks  
 (a) G<sub>0</sub> phase  
 (b) G<sub>1</sub> phase  
 (c) G<sub>2</sub> phase  
 (d) S phase
21. Homologous chromosomes are  
 (a) Similar and identical  
 (b) Identical but not similar  
 (c) Not similar and not identical  
 (d) Similar but not identical
22. The longest phase of meiosis I is  
 (a) Metaphase  
 (b) Anaphase  
 (c) Prophase  
 (d) Telophase
23. Tetrad or bivalent is  
 (a) Paired homologous chromosome but not fused complex structure  
 (b) 2 unpaired homologous chromosome  
 (c) Paired and fused complex structure  
 (d) None of these
24. Pairing of homologous chromosomes is completed in  
 (a) Leptotene  
 (b) Zygotene  
 (c) Pachytene  
 (d) Diplotene
25. Each bivalent has  
 (a) 3 chromatids  
 (b) 4 chromatids  
 (c) 5 chromatids  
 (d) 2 chromatids
26. Crossing over occurs between  
 (a) Sister chromatids  
 (b) Non sister chromatids  
 (c) Independent chromatids  
 (d) Each and every chromatid
27. Inability of chromosomes to segregate during anaphase and telophase of meiosis is called  
 (a) Crossing over  
 (b) Chromosomal disjunction  
 (c) Chromosomal nondisjunction  
 (d) None of these





# Chapter 21

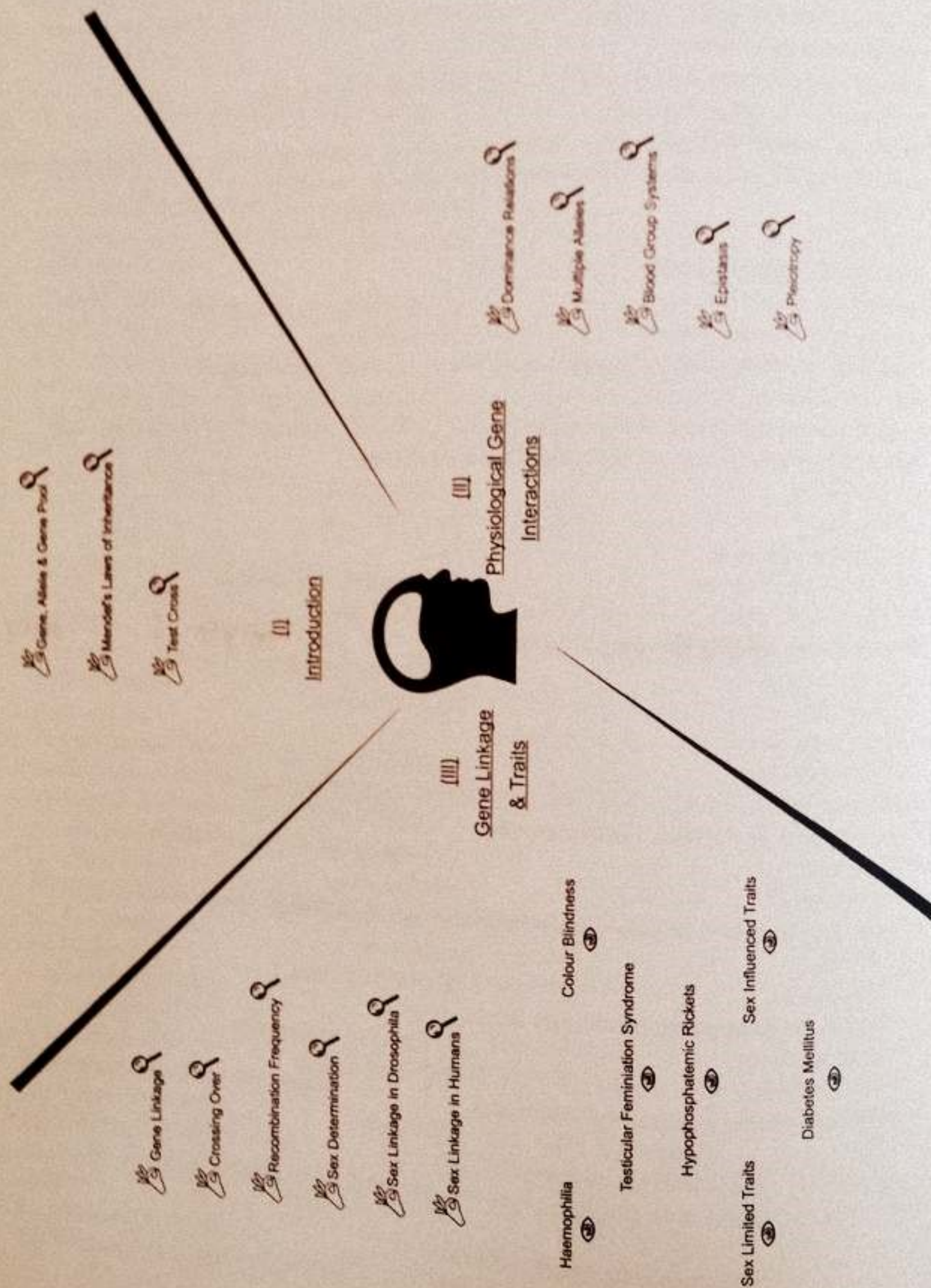
## Cell Cycle

28. Which statement is incorrect?
- Down's syndrome involves autosome
  - In Turner's syndrome  $2n-1$
  - In Klinefelter's syndrome  $XYY$
  - In Down's syndrome sperms are commonly involved
29. Apoptosis
- Cell death due to tissue damage
  - Causes inflammation
  - Internal programme of events by which cell commits suicide
  - Damages neighboring cells
30. A cell of human being has 46 chromosomes; it divides to form some daughter cells, each having 23 pairs of chromosomes. The division would be
- Mitosis
  - Meiosis
  - Amitosis
  - Budding
31. Mitosis takes place during
- Healing of wound
  - Development and growth
  - Vegetative propagation
  - All of these
32. Which of the following category comes under Turner's syndrome?
- A male having 2 X chromosomes
  - A female having 3 X chromosomes
  - A male having only 1 Y chromosome
  - A female having only 1 X chromosome
33. Morphology of chromosomes is best studied during
- Telophase
  - Metaphase
  - Prophase
  - All of these
34. Cytokinins refers to
- Division of nucleus
  - Division of cytoplasm
  - Division of cell
  - All of these
35. Which fibers interdigitate with each other?
- Astral fibers
  - Kinetochore fibers
  - Polar fibers
  - All of these
36. Cancer cells are
- Differentiated
  - Undifferentiated
  - Highly differentiated
  - Less differentiated
37. Crossing over in meiosis occurs during
- Zygotene
  - Pachytene
  - Diplojene
  - Diakinesis
38. Which division does not show replication of chromosomes?
- Mitosis
  - Meiosis I
  - Meiosis II
  - None of these
39. A significant happening of meiosis is/are
- Crossing over
  - Random assortment
  - Both of these
  - None of these
40. Jacob's syndrome can be represented as
- XO
  - XXX
  - XXY
  - XYY



# Chapter 22

## VARIATION & GENETICS





GENES, ALLELES AND GENE POOL

- *Gene* is the basic unit of biological information.
- The position of gene on the chromosome is called *locus*.
- When genes are passed in the form of intact parental combination between generations, inherited similarities are conserved but when these mutate or shuffle, variations emerge.
- Partners of a gene pair are called *alleles*.
- *Jumping genes* don't settle peacefully on their loci, they keep on hopping on different loci on the same chromosome or others
- *Phenotype* is the form of appearance of a trait.
- *Genotype* is the genetic complement (genes in an individual for a particular trait).

GENE POOL

- Any group of sexually interbreeding organisms of the same species that exist together in both time and space is called *population*.
- All the genes/alleles found in a breeding population at a given time collectively called the *gene pool*.
- *Gene pool* is the total genetic information encoded in the total genes in a breeding population existing at a given time

MENDEL'S LAWS OF INHERITANCE

- *Gregor Johann Mendel* laid the foundation of classical genetics by formulating two laws of heredity.
- Mendel performed series of breeding experiments on garden pea, *Pisum sativum* for 11 years.
- Mendel chose garden pea as his experimental plant because its flowers were hermaphrodite, it was self-fertilizing but could also be cross-fertilized, time gap between generations was short & it has many sharply distinct traits.
- Such traits which have clear cut alternative forms are called **contrasting traits**.
- A **true-breeding variety** is that which produces similar offspring upon self-fertilization.

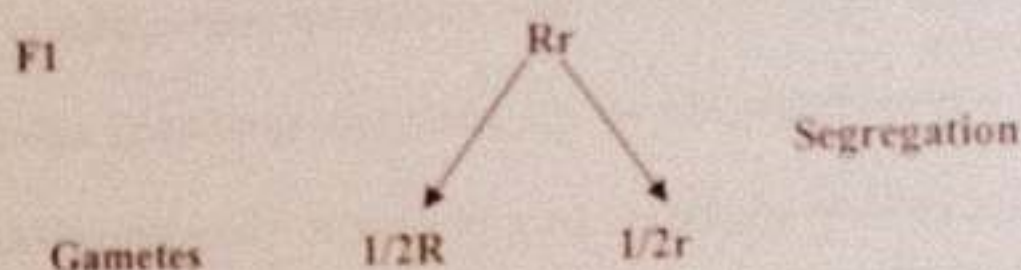
TRAIT	DOMINANT	RECESSIVE
Plant Height	Tall (6-7 feet)	Short (9-18 inches)
Flower Colour	Purple	White
Flower Position	At leaf junction (axial)	At tips of branches (terminal)
Pod Colour	Green	Yellow
Pod Shape	Inflated	Constricted
Seed Colour	Yellow	Green
Seed Shape	Round	Wrinkled

- Cross involving only one trait at a time is called *monohybrid cross*.
- Such trait which appears in F<sub>1</sub> is called *dominant*.
- Such trait, which does not appear in F<sub>1</sub> (masked by dominant) but reappears in F<sub>2</sub> is called *recessive*.
- Mendel got same **3:1** ratio in offspring of monohybrid crosses for all the seven contrasting pairs of traits
- In one particular seed shape trait, Mendel raised **F<sub>3</sub> generation** by self-fertilizing F<sub>2</sub> plants and concluded that 1/3 of F<sub>2</sub> round were like true-breeding P<sub>1</sub> round and 2/3 of F<sub>2</sub> rounds were monohybrids like F<sub>1</sub> round.



**Mendel's Interpretations**

- Mendel proposed that each contrasting form of trait was determined by *particulate* hereditary factors which he called '*elementen*'.
- Johansen renamed *elementen* as '*genes*'.
- *Dominant factor* was designated with a capital letter and *recessive factor* with a small letter.
- When both alleles of a gene pair in an organism are same, such pair is called *homozygous* and individual as *homozygote*.
- When both alleles of a gene pair in an organism are different then such pair is called *heterozygous* and individual as *heterozygote*.
- F1 offsprings are monohybrid for a particular trait; it was dominant in phenotype but heterozygous in genotype, its alleles also segregated during gamete formation.
- Segregation of alleles during gamete formation:



- According to *law of segregation*, the two coexisting alleles for each trait in an individual segregate (separate) from each other at meiosis, so that each gamete receives only one of the two alleles.
- Phenotype ratio of Mendel's Law of Segregation is 3:1 and genotype ratio is 1:2:1.

**TEST CROSS**

- *Test cross* is mating in which an individual showing a dominant phenotype is crossed with an individual showing its recessive phenotype.
- It is used to find out the homozygous or heterozygous nature of the genotype.
- Test cross of a round seed:

CASE I	CASE II
<p>If the seed is homozygous round (RR) it will grow into a pea plant that forms all gametes with only 'R' allele. Wrinkled seed plant is always homozygous recessive. It will form all gametes with 'r' allele. Fertilization will result in 100% round seed progeny.</p> <p><b>Result:</b></p> <p>All round seed progeny The tested phenotypically dominant individual is homozygous</p>	<p>If the seed is heterozygous round (Rr) it will grow into a plant that forms half the gametes with R and half with r allele. Wrinkled seed plant will form only r type of gametes. Fertilization will result into 50% round and 50% wrinkled seed progeny. Even a single wrinkled seed in the progeny is convincing proof for heterozygous nature of the round parent.</p> <p><b>Result:</b></p> <p>Half round seed and half wrinkled seed progeny The tested phenotypically dominant individual is heterozygous</p>



DIHYBRID AND DIHYBRID CROSS

- Cross in which two traits are studied at same time is called *diybrid cross*.
- According to **law of independent assortment** 'when two contrasting pairs of traits are followed in the same cross, their alleles assort independently into gametes.
- In the dihybrid cross a clear cut **9:3:3:1** phenotypic ratio was found in F<sub>2</sub>.
- Alleles for particular trait were not bound to remain in parental combinations forever rather these were free to assort independently.
- **Probability** is chance of an event to occur.
- When two independent events are occurring simultaneously like in dihybrid cross, the ratio of each joint phenotypic combination can be obtained by multiplying the probabilities of individual phenotypes. It is called **product rule**.
- The joint probability that both of the independent events will occur simultaneously is equal to the product of individual probabilities of each event.
- Independent assortment of genes depends upon independent assortment of their chromosomes.
- Only those traits assort independently whose alleles are riding on non-homologous chromosomes.
- All genes present on homologous pair of chromosomes are linked to each other in the form of a linkage group so they cannot assort independently.
- Mendel's work was published in 1866.
- **Albinos** totally lack melanin pigment in their bodies
- It is a recessive trait and two normal parents can have an albino child.



1. \_\_\_\_\_ is the basic unit of biological information.
2. \_\_\_\_\_ is the form of appearance of a trait.
3. All the genes/alleles found in a breeding population at a given time collectively called the \_\_\_\_\_.
4. Such trait, which does not appear in F<sub>1</sub> (masked by dominant) but reappears in F<sub>2</sub> is called \_\_\_\_\_.
5. \_\_\_\_\_ renamed elementen as 'genes'.
6. Phenotype ratio of Mendel's Law of Segregation is \_\_\_\_\_ and genotype ratio is \_\_\_\_\_.
7. Albinos totally lack \_\_\_\_\_ pigment in their bodies.





### DOMINANCE RELATIONS

- **Dominance** is physiological effect of an allele over its partner allele on the same locus.
- When one allele is completely dominant over the other, presence of recessive allele is functionally hidden, so heterozygote has the same phenotype as homozygote. It is called **complete dominance**.
- When the phenotype of the heterozygote is intermediate between phenotypes of the two homozygotes, it is called **incomplete or partial dominance**.
- It was first found by **Carl Correns** in 4'O Clock plant.
- Different alleles of a gene that are both expressed in a heterozygous condition are called codominant and relation is called **codominance**.
- In **over dominance** the over dominant heterozygote exceeds in quantity the phenotypic expression of both the homozygotes.

RELATION	EXAMPLE
Complete dominance	All traits of pea plant
Incomplete dominance	4 O' clock plant
Codominance	MN & ABO blood types
Overdominance	Heterozygous red eyed Drosophila

- **Landsteiner and Levine** discovered MN blood types in man on the basis of specific antigens present on RBC
- RBC antigen induce production of specific antibodies

### MN BLOOD GROUP SYSTEM

PHENOTYPE	GENOTYPE	FORM	ANTIGENS ON RBC
M	$L^M L^M$	Homozygous	M
N	$L^N L^N$	Homozygous	N
MN	$L^M L^N$	Heterozygous	M & N

### MULTIPLE ALLELES

All such altered alternate forms of a gene, whose number is more than two are called multiple alleles.

### ABO BLOOD GROUP SYSTEM IN MAN

- ABO blood group system was discovered by **Karl Landsteiner** in 1901
- **Bernstein** explained the genetic basis of ABO system in 1925
- This system is encoded by a **single polymorphic gene I on chromosome 9**
  - Mutation 1 →  $I^A$
  - Mutation 2 →  $I^B$
  - Mutation 3 →  $i$

These three are multiple alleles
- Allele  $i$  does not specify any antigen
- Blood group phenotype of a person never changes throughout life





- Anti-A and anti-B antibodies appear in plasma during the first few months after birth

BLOOD GROUP	GENES	COMBINATION	ANTIGEN	ANTIBODIES
A	$I^A I^A$	Homozygous	A	Anti B
	$I^A i$	Heterozygous	A	Anti B
B	$I^B I^B$	Homozygous	B	Anti A
	$I^B i$	Heterozygous	B	Anti A
AB	$I^A I^B$	Heterozygous	A & B	No
O	$ii$	Homozygous	No	Anti A & Anti B

- The blood serum containing anti-bodies is called *antisera*
- Blood group transfusion is safe if it Does not cause agglutination in the Recipient
- Blood group A can be transfused to  $\rightarrow$  A, AB. Similarly  
 $B \rightarrow B, AB$   
 $AB \rightarrow$  only AB  
 $O \rightarrow A, B, AB, O$
- O recipient can only have a transfusion from O person
- A and B antigens can also be present in saliva and other body fluids of some persons called *secretors*. Secretors have dominant secretor gene "*Se*" on chromosome 19
- O blood group individuals are called *universal donors* and AB individuals are called *universal recipients*
- For disputed paternity blood type data and DNA finger printing test is done but latter is more seriously considered

### Rh BLOOD GROUP SYSTEM

PHENOTYPE	GENOTYPE	FORM	ANTIGEN	ANTI BODY
Rh positive	DD	Homozygous	Rh factor	No
	Dd	Heterozygous	Rh factor	No
Rh negative	dd	Homozygous	No	No

- Rh blood group system is defined on the basis of Rh factor present on the surface of RBC
- This system is named Rh after Rhesus monkey because its antigen was first discovered by Land Steiner in 1930
- **Erythroblastosis fetalis** (maternal-foetal Rh incompatibility) results when an  $Rh^-$  woman, married to an  $Rh^+$  man, conceives a child who is  $Rh^+$
- It can be protected by injecting anti-Rh antiserum. Mild ABO incompatibility also provides some protection.

### EPISTASIS

- When an effect caused by a gene or gene pair at one locus interferes with or hides the effect caused by another gene or gene pair at another locus, such a phenomenon of gene interaction is called **epistasis**.
- Common example is ABO antigen specificity.



PLEIOTROPY

- When a single gene affects two or more traits, the phenomenon is called *pleiotropy*. Such a gene with multiple phenotypic effects is called *pleiotropic*.
- Common examples are (i) White eye gene in *Drosophila* also affects shape of spermatheca, (ii) Growth gene in humans affects both height and weight. (iii) Fur colour in cat and sound sensation are controlled by common gene.

CONTINUOUSLY VARYING TRAITS

- A *continuously varying trait* is encoded by alleles of two or more different gene pairs found at different loci, all influencing the same trait in an additive way.
- Qualitative differences are large and more obvious but quantitative differences are small and less striking.
- A continuously varying trait is encoded by alleles of two or more different gene pairs found at different loci, all influencing the same trait in an additive way. Those quantitative traits are called *polygenic traits* and their genes are *polygenes*.
- *Human skin colour* is controlled by 3-6 gene pairs.
- *Tongue rolling* is quantitative trait controlled by single dominant gene.
- *Multifactorial traits* are controlled both by genes and environment.

Phenotypes of Wheat Grain Colour

GENOTYPE	PHENOTYPE
AABBCC	Dark red
Aabbcc	White
Aabbcc/ aaBbcc/ aabbCc	Light pink
AAbbcc/ aaBBcc/ aabbCC/ AaBbcc/ aaBbCc/ AabbCc	Pink
AaBbCc/ AABbcc/ AabbCC	Light red
AABBcc/ aaBBCC/ AAbbCC	Red
AABBCc/ AABbCC/ AaBBCC	Moderately dark red



1. \_\_\_\_\_ is physiological effect of an allele over its partner allele on the same locus.
2. All such altered alternate forms of a gene, whose number is more than two are called \_\_\_\_\_.
3. \_\_\_\_\_ explained the genetic basis of ABO system in 1925.
4. The blood serum containing anti-bodies is called \_\_\_\_\_.
5. Secretors have dominant secretor gene "Se" on chromosome \_\_\_\_\_.
6. When a single gene affects two or more traits, the phenomenon is called \_\_\_\_\_.

Answers: (1) Dominance (2) Multiple Alleles (3) Bernstein (4) Antiserum (5) 19 (6) Pleiotropy



- Phenomenon of staying together of all the genes of a chromosome is called *gene linkage*.
- Linked genes do not follow law of independent assortment.
- A chromosome carries its linked genes en block in the form of a *linkage group*.
- The *number of linkage groups* corresponds to the number of homologous pairs of chromosomes.
- Man has 23 linkage groups.
- Genes for colour blindness, haemophilia, gout form one linkage group on *human X-chromosome*.
- Gene for sickle cell anemia, leukemia and albinism make linkage group on *human chromosome 11*.

### CROSSING OVER

- *Crossing over* is an exchange of segments between non-sister chromatids of homologous chromosomes during meiosis.
- Crossing over minimizes the chances of gene linkage.
- *Cross over or recombination frequency* is the proportion of recombinant types between two gene pairs as compared to the sum of all combinations.
- Its value is directly proportional to distance between the genes on gene map.

### SEX DETERMINATION

- Chromosomes having genes for determination of sex are called *sex chromosomes*.
- All chromosomes other than sex chromosomes are called *autosomes*.
- A gamete without any sex chromosome is called *nullo gamete*.

#### Patterns of Sex Determination

FEATURE	XO-XX	XY-XX	XX-XY/WZ-ZZ
Examples	Grasshopper, Protenor bug	Drosophila, Man	Birds, Butterflies, Moth
Male	XO	XY	XX
	Heterogametic	Heterogametic	Homogametic
Male gametes	2 types (X & nullo)	2 types (X & Y)	1 type (X)
Female	XX	XX	XY
	Homogametic	Homogametic	Heterogametic
Female gametes	1 type (X)	1 type (X)	2 types (X & Y)
Sex determining structure	Sperm	Sperm	egg

#### Comparison of Drosophila & Humans

FEATURE	DROSOPHILA	MAN
Total pairs	4	23
Autosome pairs	3	22
Sex chromosome pair	1 (XX in female & XY in male)	1 (XX in female & XY in male)





Sex determination by	X chromosome – autosome balance	X & Y chromosome system
Turners syndrome (XO)	Sterile male	Sterile female
Klinefelter's syndrome (XXY)	Fertile female	Sterile male

### SEX LINKAGE IN DROSOPHILA

- Male and female drosophila shows *sexual dimorphism*.
- **Male** is smaller in size with black rounded abdomen. Male has sex combs on front legs. **Female** is larger with pointed abdomen.
- *Drosophila* has generation time of just **two weeks**.
- Morgans and his colleagues studies **85 traits** of *Drosophila*.
- Normal fruitflies, the **wild type**, have bright red eyes.

### SEX LINKAGE IN HUMANS

- A trait whose gene is present on X chromosome is called **X-linked trait**. X-linked traits are commonly referred as sex-linked traits.
- **X-linked recessive traits** are common in male while **X-linked dominant traits** are common in female.
- X-linked traits follow **zig zag path** while Y-linked traits are transmitted in **straight way**.
- Genes located on Y chromosomes are called Y-linked genes and their traits are called **Y-linked traits**.
- Such traits whose genes are located on both X & Y chromosomes are called X & Y linked or **pseudoautosomal traits**.
- Such genes which are present both on X and Y chromosome are called X-and-Y linked genes.

### HAEMOPHILIA

- **Haemophiliac's** blood fails to clot properly after an injury, because it has either reduction or malfunction or complete absence of blood clotting factors.
- **Haemophilia A and B** are non-allelic recessive sex-linked but **haemophilia C** is an autosomal recessive trait.
- **80%** haemophilics suffer from haemophilia A due to abnormality of factor VIII, about **20%** suffer from haemophilia C due to reduction in factor IX but less **1%** suffer from hemophilia C due to reduction in factor factor XI.

### COLOUR BLINDNESS

- Normal trichromatic colour vision is based on three different kinds of cone cells in the retina.
- The genes for red and green opsins are on X chromosome while the gene for blue opsin is present on autosome 7.
- A **dichromat** can perceive two primary colours but is unable to perceive one whose opsins are missing due to mutation.
- **Protanopia** is red blindness, **deutanopia** is green blindness while **tritanopia** is blue blindness.
- A **monochromat** can perceive only one colour. Monochromacy is true colour-blindness. **Blue cone monochromacy** is most common where a person cannot perceive red and green.



- **Testicular feminization syndrome** is a rare X-linked recessive trait in which person has X & Y chromosomes yet the genes develop them physically into female.
- A **sex-limited trait** is limited to only one sex due to anatomical differences e.g. beard growth in human male and milk yield in cows.
- **Sex influenced traits** occur in both males and females but they are more common in one sex e.g. pattern baldness. These are influenced by hormonal differences.

### TRAITS AND EXAMPLES

TRAIT	EXAMPLE
X-linked recessive	Hemophilia, colour blindness, testicular feminization syndrome
X-linked dominant	Hypophosphatemic or vitamin D resistant rickets
Y-linked trait	Maleness
Pseudoautosomal trait	Bobbing in insects
Sex limited trait	Milk yield in cow, beard in man
Sex influenced trait	Baldness

### DIABETES MELLITUS

- **Diabetes** is a heterogeneous group of disorders, which are characterized by elevated blood sugar level.
- About 2%-5% of type II diabetics get the disease early in life, before 25 years of age. It is called maturity onset diabetes of the young (MODY).

FEATURE	TYPE I	TYPE II
Other name	IDDM	NIDDM
	Juvenile diabetes	Senile diabetes
Age of incidence	Before 40 years	After 40 years
Cause	Decreased insulin production due to autoimmune response	Increased resistance of cells to insulin mainly due to obesity
Percentage	10%	90%
Treatment	Exogenous Insulin	Exercise



1. Gene for sickle cell anemia, leukemia and albinism make linkage group on human chromosome \_\_\_\_\_.
2. A gamete without any sex chromosome is called \_\_\_\_\_.
3. *Drosophila* has generation time of just \_\_\_\_\_.
4. Gene for blue opsin is present on chromosome \_\_\_\_\_.
5. If type II diabetes occurs before 25-years of age, it is called \_\_\_\_\_.

Answers: (1) 11 (2) Nullo Gamete (3) 2 Weeks (4) 7 (5) MODY

Answers:





## VALUES

Property	Value
Number of contrasting traits studied by Mendel	7
Number of pure-breeding lines studied by Mendel	14
Phenotype ratio of Mendel's law of segregation	3:1
Genotype ratio of Mendel's law of segregation	1:2:1
Phenotype ratio of Mendel's law of independent assortment	9:3:3:1
Maximum possible number of alleles for a gene	300
Chromosome number having alleles for ABO	9
Chromosome number having secretor gene	19
Chromosome number having H locus	19
Number of gene pairs controlling wheat grain colour	3 pairs (6 alleles)
Number of gene pairs controlling human skin colour	3-6 pairs
Number of gene pairs controlling human height	Many pairs having multiple alleles
Linkage groups in man	23
Chromosome number having gene for sickle cell anemia, leukemia & albinism	11
Homologous pairs of chromosome in <i>Drosophila</i>	4
Number of autosome pairs in <i>Drosophila</i>	3
Pair of sex chromosome in <i>Drosophila</i>	1
Total chromosome in man	46 (23 pairs)
Autosome pairs in man	22
Sex chromosome pair in man	1
Number of chromosome in female grasshopper	24
Number of chromosome in male grasshopper	23
Number of chromosomes in female <i>Ascaris incurva</i>	42 (8 pairs of compound X + 13 pairs of autosomes (16+26))
Number of chromosomes in male <i>Ascaris incurva</i>	35 (8X + 1Y + 13 pairs of autosomes (8+1+26))
X:A ratio for <i>Drosophila</i> to be female	1.00 or higher
X:A ratio for <i>Drosophila</i> to be male	0.5 or below





## Chapter 22

### Variation & Genetics

Generation time of Drosophila

Traits of Drosophila studied by Morgan

Persons suffering from hemophilia A

Persons suffering from hemophilia B

Persons suffering from hemophilia C

Autosome number having gene for blue opsins

Age for incidence of Diabetes type I

Age for incidence of Diabetes type II

Percentage of Type I

Percentage of Type II

Percentage of MODY in 90% type II

Age of incidence of MODY

%age of MODY caused by mutations in glucokinase enzyme

Chromosome having insulin gene

2 weeks

85

80%

20%

Less than 1%

7

Before 40

After 40

10%

90%

2-5%

Before 25 years

50%

11





## PRACTICE EXERCISE



- In which of the following cases, genotypic and phenotypic ratio will remain same in  $F_2$  generation  
 (a) Law of independent assortment (b) Law of Segregation  
 (c) Test cross (d) Incomplete dominance.
- A pure breeding tall pea plant was crossed to dwarf plant what will be the frequency of dwarf plants in  $F_1$   
 (a) 0.25 (b) 0.50  
 (c) 0.75 (d) 0.0
- In question number 2 what will be frequency of dwarf plants in  $F_2$   
 (a) 0.25 (b) 0.50  
 (c) 0.75 (d) 0.0
- How many pairs of homologous chromosomes are present in *Pisum sativum*  
 (a) Five pairs (b) Six pairs  
 (c) Seven pairs (d) Eight pairs.
- Which of the following characters of pea plant is dominant?  
 (a) Axial flowers (b) Yellow pods  
 (c) White flowers (d) Wrinkled seeds
- A pea plant with yellow seed was crossed to a plant having green seeds. What will happen in  $F_1$ ; if plants are true breeding  
 (a) All seeds will be yellow (b) Half of seeds will be yellow  
 (c) All the seeds will be green. (d) Both will be present in ratio of 1:2:1
- The position of a gene on chromosome is called  
 (a) Habitat (b) Position  
 (c) Locus (d) Location
- Filial is a Latin word. It means  
 (a) Spring (b) Issue  
 (c) Progeny (d) Descendent
- Which of the following condition is hybrid  
 (a) TT (b) Tt  
 (c) tt (d) All of these.
- Which of the following is monohybrid cross  
 (a) TT x tt (b) TTYy x TTyy  
 (c) Both of these (d) None of these.
- A pure breeding tall plant was crossed to dwarf plant. What would be probability of "Tt" genotype in  $F_2$   
 (a) 0.25 (b) 0.50  
 (c) 0.75 (d) 0.0
- A monohybrid cross yielded 3:1 in  $F_2$ . What could be mode of inheritance?  
 (a) Segregation (b) Independent assortment  
 (c) Both of these (d) None of these.
- If a heterozygous individual shows the complete effect of both alleles, the type of inheritance would be  
 (a) Complete dominance (b) Non dominance  
 (c) Incomplete dominance (d) Co-Dominance
- The gene which controls ABO group has how many alleles in an individual  
 (a) One (b) Two  
 (c) Three (d) Four.



15. How many genes control Rh blood group system?  
 (a) One (b) Two  
 (c) Three (d) Four
16. A man with blood group "A" marries a woman of blood group "B". Both are heterozygous. What is the off-springs having phenotype "O"?  
 (a) Zero (b) 25%  
 (c) 50% (d) 75%
17. The trait "Kernel colour in corn" is controlled by how many pairs of genes?  
 (a) One pair (b) Two pairs  
 (c) Three pairs (d) Many pairs
18. Baldness is most frequent in  
 (a) Men (b) Women  
 (c) Children (d) Girls
19. In nature, Garden pea is  
 (a) Self-fertilized (b) Cross fertilized  
 (c) Cross pollinated (d) None of these
20. The genes which do not follow law of independent assortment  
 (a) Crossed genes (b) Linked genes  
 (c) Recessive genes (d) Dominant genes
21. Phenotype represents  
 (a) Morphology (b) Physiology  
 (c) Genetics (d) None of these
22. During test cross, if all offsprings are phenotypically dominant then parents are  
 (a) Homozygous (b) Heterozygous  
 (c) One homozygous other heterozygous (d) None of these
23. True breeding variety is produced by  
 (a) Self fertilization (b) Cross fertilization  
 (c) Both of these (d) None of these
24. Genotype ratio of Mendel's law of independent assortment is  
 (a) 3:(a) (b) 1:2:1  
 (c) 9:3:3:(a) (d) None of these
25. Which of the following is universal donor?  
 (a) A (b) B  
 (c) AB (d) O
26. Such inheritance in which traits vary quantitatively is  
 (a) Continuously varying trait (b) Incomplete dominance  
 (c) Test cross (d) Polygenic inheritance
27. Inheritance in man is traced by  
 (a) Mathematical method (b) Genetic method  
 (c) Statistical method (d) Pedigree method
28. Skin colour in man is controlled by  
 (a) 1 pair (b) 2 pairs  
 (c) 4 pairs (d) 8 pairs
29. Feature correct to O-negative blood group  
 (a) A,B antigen present (b) Anti-A, Anti-B antibody present  
 (c) Rh antigen present (d) Rh antibody present
30. Which of the following blood group is always heterozygous?  
 (a) A (b) B  
 (c) AB (d) O
31. Interaction between genes occupying different loci is  
 (a) Dominance (b) Epistasis  
 (c) Pleiotropy (d) None of these



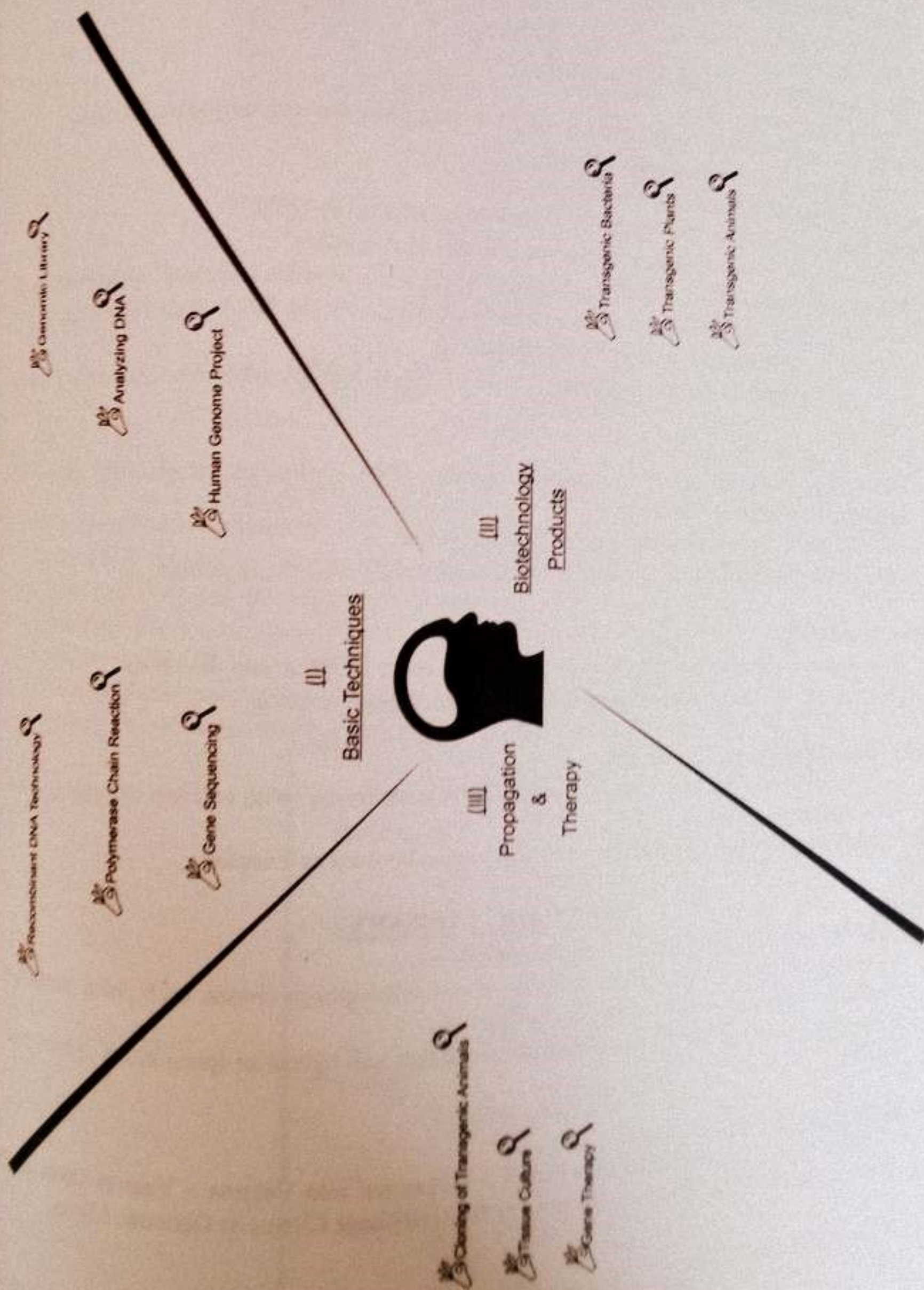


32. Genes that affect growth rate in humans influencing both weight and height are  
(a) Codominant (b) Epistasis  
(c) Pleiotropy (d) Polygene
33. All of the following are continuously varying traits except  
(a) Kernel colour in wheat (b) Skin colour in humans  
(c) Height in humans (d) Tongue rolling in humans
34. The number of linkage groups in humans is  
(a) 12 (b) 23  
(c) 46 (d) 92
35. Recombination frequency between two linked genes can be calculated by  
(a) Back cross (b) Test cross  
(c) Normal cross (d) None of these
36. Which of the following is male determining gene in humans?  
(a) tfm (b) SRY  
(c) Both of these (d) None of these
37. It was discovered by J.Seiler in 1914 in moth.  
(a) XO-XX (b) XY-XX  
(c) ZZ-ZW (d) None of these
38. Haemophilia B is due to abnormality of factor  
(a) VIII (b) IX  
(c) X (d) XI
39. Gene for blue opsin is present on chromosome.  
(a) X (b) Y  
(c) 7 (d) 11
40. Most common type of Diabetes mellitus is  
(a) Type I (b) Type II  
(c) MODY (d) None of these



# Chapter 23

## BIOTECHNOLOGY





### CLONING OF A GENE

### RECOMBINANT DNA TECHNOLOGY

- **Recombinant DNA** contains DNA from two different sources.
- **Four requirements** of recombinant DNA technology are:
  - Gene of interest.
  - Molecular scissors
  - Molecular carrier or vector
  - Expression system
- Gene can be synthesized in the lab from mRNA using *reverse transcriptase*. The DNA molecule is called **complementary DNA**.

#### **Molecular Scissors: Restriction Endonucleases**

- First **restriction enzyme** was isolated by Hamilton O. Smith in 1970.
- They are called so because they restrict the growth of viruses.
- **Palindromic sequences** are sequences of four or six nucleotides arranged symmetrically in the reverse order produced by restriction enzymes, which cut the DNA at specific sites.
- **EcoRI** is a commonly used restriction enzyme.
- The single stranded but complementary ends of the two DNA molecules are called **sticky ends**.

#### **Molecular Carrier: Vector**

- **Plasmids** are natural extra chromosomal circular DNA molecules which carry genes for antibiotic resistance and fertility.
- **pSC 101** has antibiotic resistance gene for tetracycline.
- **pBR 322** has antibiotic resistance gene for tetracycline as well as ampicillin.

#### **Recombinant DNA**

- **DNA ligase** is the enzyme which seals the foreign piece of DNA into the vector
- This new DNA is known as **recombinant DNA or chimaeric DNA**

#### **Expression of the Recombinant DNA**

- Bacterial cells take up recombinant plasmid if they are treated with calcium chloride to make them more permeable
- **Lambda phage** (DNA of bacterial viruses) can also be used as a vector

### GENOMIC LIBRARY

- A **genome** is a full set of genes of an individual.
- A **genomic library** is a collection of bacterial or bacteriophage clones, each clone containing a particular segment of DNA from the source cell.
- A **probe** is a single stranded nucleotide sequence that will hybridize (pair) into a certain piece of DNA.

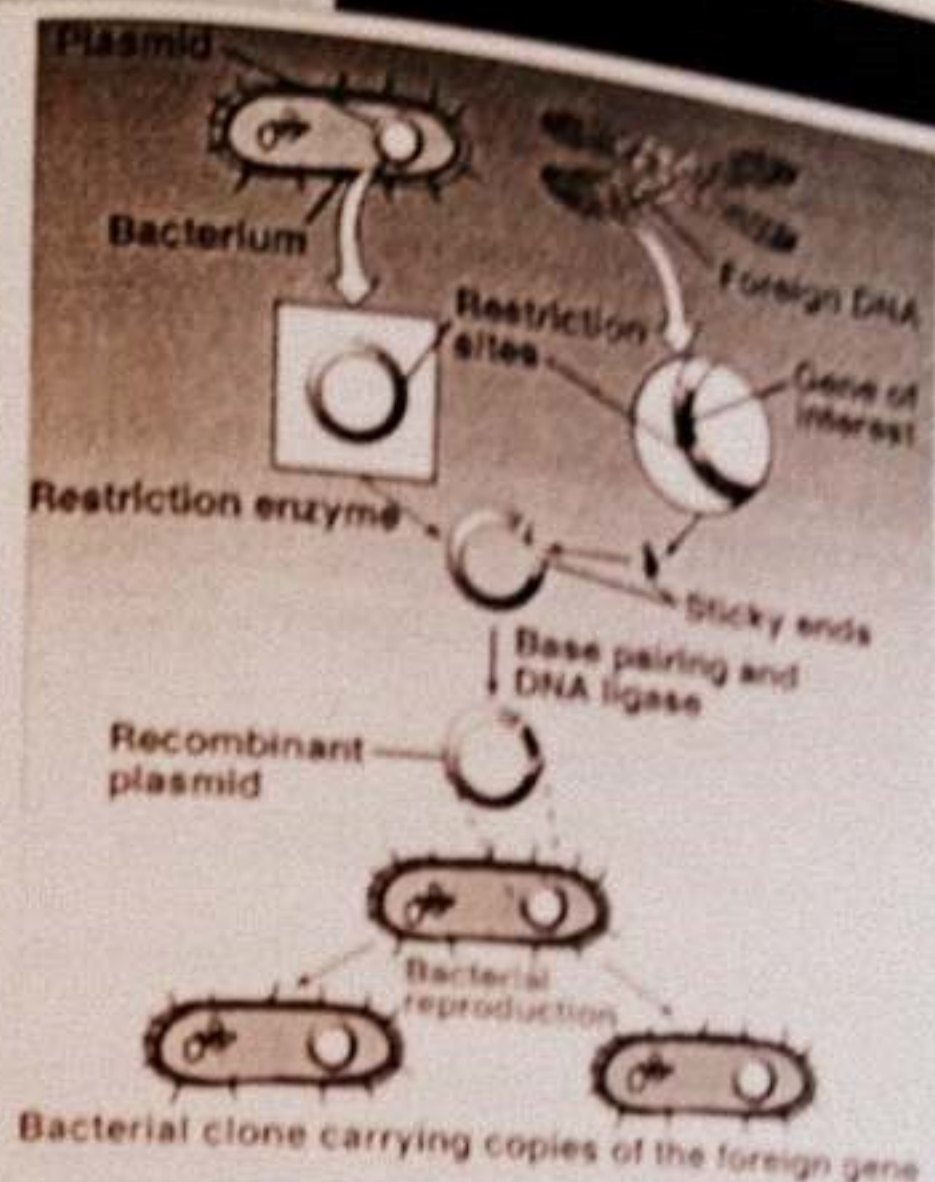
#### **Development of Genomic Library**

Genome of an Individual > Sliced into Pieces > Pieces put into Vectors > Vectors taken up by Host Bacteria > Entire Collection of Bacteria or Bacteriophage Clones as Genomic Library

#### **Searching a Specific Gene**

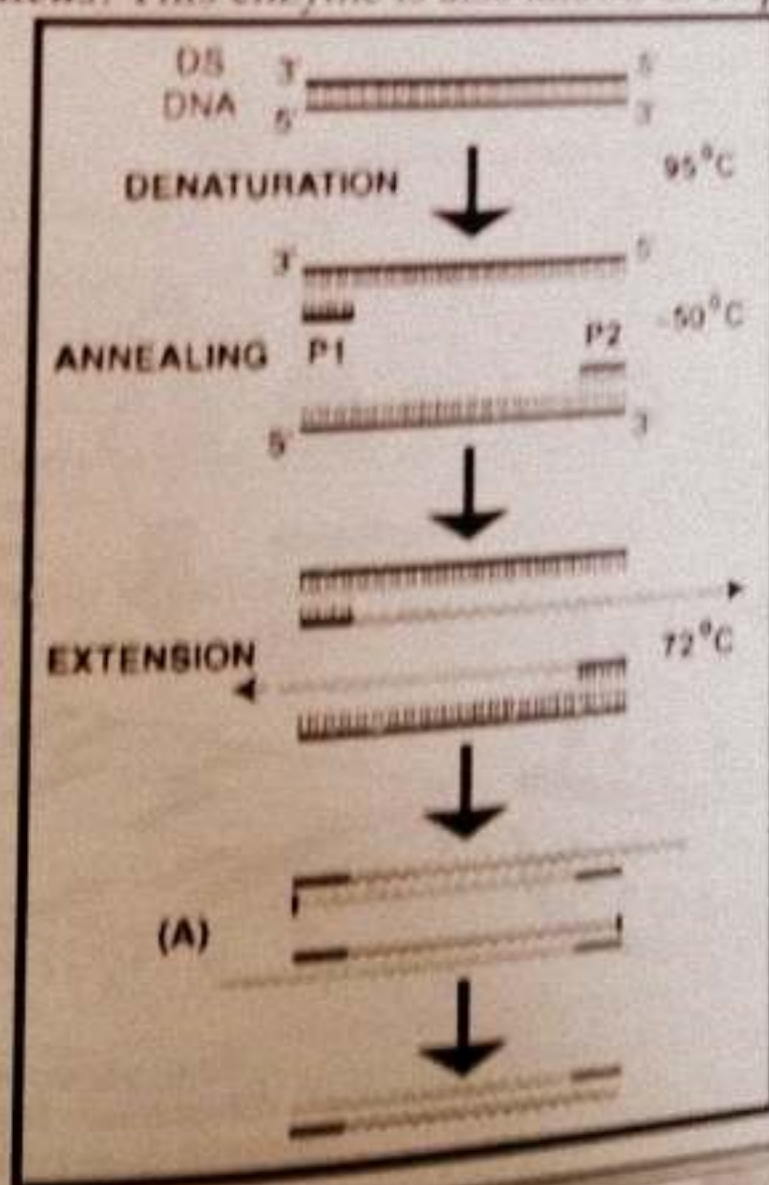
Bacterial cells plated onto Agar > Application of Probe > Probe Hybridizes into Gene of Interest > Hybrid is located due to radioactivity or fluorescence > Gene isolation





### POLYMERASE CHAIN REACTION

- **Polymerase chain reaction (PCR)** was developed by Kary B. Mullis in 1983.
- PCR takes its name from DNA polymerase. But keep it in mind that DNA polymerase does not start the replication process but only continues or extends it.
- **Primers** are the sequences of about 20 bases that are complementary to the bases on either side of the target DNA.
- DNA polymerase used is **temperature-insensitive** (thermostable) enzyme extracted from the bacterium *Thermus aquaticus*. This enzyme is also known as *Taq polymerase*.



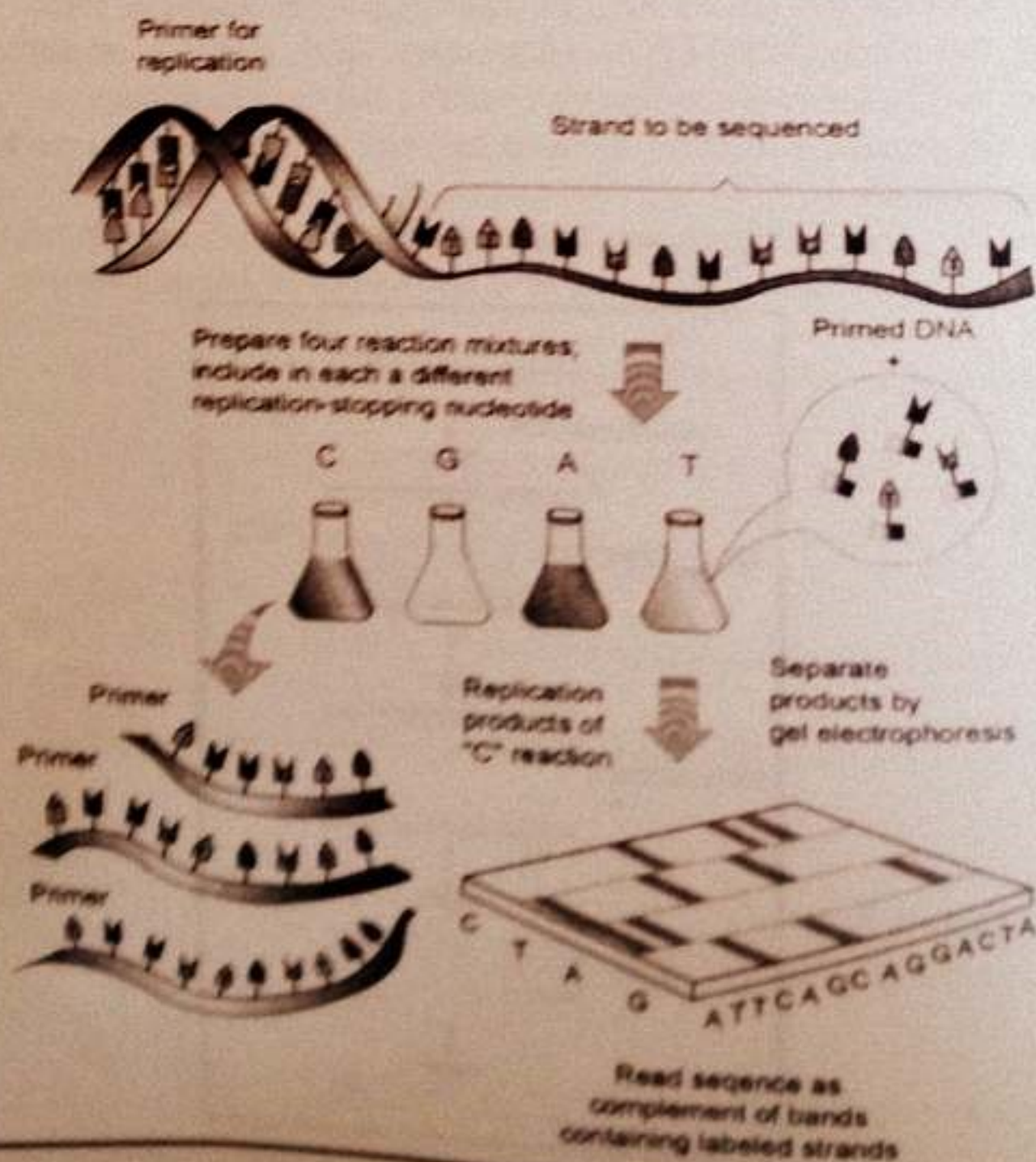


ANALYZING DNA

- It is also called DNA finger printing.
- Gel electrophoresis is the process by which DNA fragments can be isolated according to their length.
- Probe is used as genetic marker.
- DNA from a single sperm is enough to identify a suspected rapist.
- As DNA is inherited so its finger print resembles that of one's parents.
- PCR is used to
  - Diagnose viral infections, genetic disorders and cancer
  - In forensic labs to identify criminals
  - To determine evolution

GENE SEQUENCING

- **Sanger's method** is in which dideoxynucleoside triphosphates are used to terminate DNA synthesis at different sites.
- **Maxam-Gilbert method** is in which DNA threads are chemically cut into pieces of different sizes.
- Genomes of organisms which have been sequenced: Plant chloroplasts, animal mitochondria, bacteria, yeasts, *Drosophila*, *Arabidopsis*, mouse and human





- Main goals of human genome project are to construct gene sequence map on chromosome and base sequence map of genes.
- DNA sequence of human chromosome no. 22 was completed in 1999.
- Human genome is **25 times** larger than any other genome sequenced so far.
- **Craig Venter** has founded a company by the name "**Celera**" which has sequenced the entire genome



1. Gene can be synthesized in the lab from mRNA using reverse transcriptase. The DNA molecule is called \_\_\_\_\_.
2. First restriction enzyme was isolated by \_\_\_\_\_ in 1970.
3. pSC 101 has antibiotic resistance gene for \_\_\_\_\_.
4. A \_\_\_\_\_ is a full set of genes of an individual.
5. DNA polymerase used in PCR is extracted from \_\_\_\_\_.
6. \_\_\_\_\_ method is in which dideoxyribonucleoside triphosphates are used to terminate DNA synthesis at different sites.
7. Human genome is \_\_\_\_\_ times larger than any other genome sequenced so far.

### BIOTECHNOLOGY PRODUCTS

- Organisms that have had a foreign gene inserted into them are called **transgenic organisms**.

#### Transgenic Bacteria

- Transgenic bacteria are produced in large vats called **bioreactors**.
- Transgenic bacteria are produced to promote health of plants e.g. frost-plus bacteria have been changed into frost-minus bacteria..
- Produce products such as insulin, GH, tPA, factor 8, hep B vaccine.
- They can be used as **biofilters** to prevent airborne chemical pollutants from being vented into the air.
- They are used for cleansing up beaches after oil spills.
- They carry out synthesis of some organic chemicals such as dipeptide sweetener called **neutrasweet**.

Answers: (1) Complementary DNA (2) Hamilton O'Smith (3) Tetracycline (4) Genome (5) *Thermus aquaticus* bacterium (6) Sanger's (7) 25





### Transgenic Plants

- Transgenic plants are produced when foreign genes are introduced into immature plant embryos or into protoplasts. It is possible to treat protoplasts with an electric current while they are suspended in a liquid containing foreign DNA. The electric current makes tiny, self-sealing holes in the plasma membrane through which genetic material can enter.
- Plant cells from cell wall has been removed are called **protoplast**.
- A weed called **mouse-eared cress** has been engineered to produce a biodegradable plastic (polyhydroxy-butyrate) in cell granules.
- One type of **antibody** made by corn can deliver radioisotopes to tumor cells and another made by soybeans can be used as a treatment for genital herpes. Plant made antibodies are inexpensive and there is little worry about contamination with pathogens.
- Stomata can be altered to boost carbon dioxide intake or cut down on water loss.
- Another possible goal is to increase the efficiency of Rubisco which captures  $\text{CO}_2$  in most plants.
- Plants are being engineered to produce human hormones, clotting factors and antibodies in their seeds.

### Transgenic Animals

- Transgenic animals have been developed by inserting genes into the eggs of animals.
- In order to get transgenic animals, **two methods** are used i.e. **microinjection** (by hand) and **vortex method** by inserting gene into egg. In Vortex method the eggs are placed in an agitator with DNA and silicon-carbide needles. The needles make tiny holes through which the DNA can enter.
- **Gene farming** is the use of transgenic farm animals to produce pharmaceuticals.
- **Urine is a preferable vehicle** for a biotechnology products than milk because:
  - All animals in herd urinate while only females produce milk.
  - Animals start to urinate at birth while female do not produce milk until maturity.
  - It is easier to extract proteins from urine than from milk.

### CLONING OF TRANSGENIC ANIMALS

- In 1997 scientists at **Rosalin institute** in Scotland announced that that they have achieved the target of cloning the transgenic animals
- **Cumulus cells** are those that cling to the eggs to divide and begin development after ovulation occurs.

### GENE THERAPY

- **Gene therapy** is the insertion of genetic material into human cells for the treatment of a disorder.
- There are two main methods for gene therapy i.e. **Ex-vivo & In-vivo**.
- Various diseases treated with gene therapy are SCID, familial hypercholesterimia, cystic fibrosis, cancer, coronary artery blockage, AIDS, hemophilia and diabetes.
- **SCID** is due to deficiency of enzyme called adenosine deaminase (AD(a)).
- Familial hypercholesterolemia is a condition that develops when liver cells lack a receptor for removing cholesterol from blood.



Cystic fibrosis patients lack a gene that codes for trans-membrane carrier of the chloride ion.

### TISSUE CULTURE

- **Tissue culture** is the growth of a tissue in an artificial liquid culture medium.
- German botanist Gottlieb Haberlandt said in 1902 that plant cells are totipotent.
- Cornell botanist F.C. Steward grew a complete carrot plant from a tiny piece of phloem.
- Coconut milk contains cytokinins (plant hormone) that induces cell division.
- Micropropagation is a commercial method of producing thousands, even millions of identical seedlings in a limited amount of space.

TYPE	ADVANTAGE
Meristem culture	Virus free
Anther culture	Expression of homozygous recessive traits
Cell suspension culture	Production of materials in short time

- A gene for the production of the firefly enzyme luciferase was inserted into tobacco protoplast and the adult plant glowed when sprayed with the substrate luciferin.
- In 1987, John C Sanford and Theodore M. Klein of Cornell University developed particle gun method to introduce gene into cell. In salt-tolerant plant Arabidopsis, a channel protein has that transports  $\text{Na}^+$  into the vacuole.
- $\alpha$ -galactosidase enzyme that can be used to treat a human lysosomal storage disease has been produced by transgenic tobacco plant.
- Transgenic tobacco plants are used to produce antigens to treat Non-Hodgkin's lymphoma.

### IMPROVED AGRICULTURAL TRAITS

Herbicide resistant	Wheat, rice, sugar beets, canola
Salt tolerant	Cereals, rice, sugarcane
Drought resistant	Cereals, rice, sugarcane
Cold tolerant	Cereals, rice, sugarcane
Improved yield	Cereals, rice, corn, cotton
Modified wood pulp	Trees

### IMPROVED FOOD QUALITY TRAITS

Fatty acid/ oil content	Corn, soybeans
Proteins, starch content	Cereals, potatoes, soybeans, rice, corn
Amino acid content	Corn, soybean
Disease protected	Wheat, corn, potatoes





## Chapter 23

## Biotechnology



1. Transgenic bacteria are produced in large vats called \_\_\_\_\_.
2. Transgenic bacteria carry out synthesis of some organic chemicals such as dipeptide sweetener called \_\_\_\_\_.
3. A weed called \_\_\_\_\_ has been engineered to produce a biodegradable plastic (polyhydroxybutyrate) in cell granules.
4. \_\_\_\_\_ is a preferable vehicle for a biotechnology product than milk.
5. \_\_\_\_\_ are those cells that cling to the eggs to divide and begin development after ovulation occurs.
6. Transgenic tobacco plants are used to produce \_\_\_\_\_ to treat Non-Hodgkin's lymphoma.

## VALUES

Property	Value
Number of restriction endonucleases isolated so far	400
Number of restriction endonucleases frequently used in recombinant DNA technology	20
Plasmid having antibiotic resistance gene for tetracycline	pSC 101
Plasmid having antibiotic resistance gene for tetracycline & ampicillin	pBR 322
Number of bases in primer sequence	20
Human genome is larger than any other genome sequenced so far by	25 times
Reduction of crop production today due to salinization than earlier is by	50%

Answers: (1) Bioreactors (2) Nutrasweet (3) Mouse Eared Cress (4) Urine (5) Cumulus Cells (6) Antigens



## PRACTICE EXERCISE



Recombinant DNA contains DNA from

- (a) 2 different sources
- (b) 3 different sources
- (c) 2 same sources
- (d) 3 same sources

First restriction enzyme was isolated by

- (a) Kary Mullis
- (b) Hamilton O. Smith
- (c) Maxam Gilbert
- (d) Hamilton John

Commonly used restriction enzyme is

- (a) pSC 101
- (b) pBR 322
- (c) EcoRI
- (d) All of these

Natural extrachromosomal circular DNA molecules carrying genes for antibiotic resistance and fertility

- (a) Recombinant DNA
- (b) Chimaeric DNA
- (c) Lambda phage
- (d) Plasmids

Which one has antibiotic resistance gene for tetracycline and ampicillin?

- (a) pSC101
- (b) pBR322
- (c) pCR322
- (d) None of these

The enzyme which seals the foreign DNA into the vector is

- (a) Restriction endonuclease
- (b) DNA polymerase
- (c) DNA ligase
- (d) DNA mutase

Chimaeric DNA is also known as

- (a) Recombinant DNA
- (b) Complementary DNA
- (c) Vector
- (d) Plasmid

Lambda phage is

- (a) Virus
- (b) Bacterium
- (c) Plasmid
- (d) Host cell

A genomic library is a collection of

- (a) Bacterial clones
- (b) Bacteriophage clones
- (c) Viral clones
- (d) Both a and b

A single stranded nucleotide sequence that will hybridize into a certain piece of DNA is

- (a) Primer
- (b) Probe
- (c) Genome
- (d) Both a & b

Which statement is not true about PCR?

- (a) Developed by Kary Mullis
- (b) Take its name from DNA polymerase
- (c) Is not very specific
- (d) Taq polymerase is used

Taq polymerase is extracted from a bacterium

- (a) *Floral aquaticus*
- (b) *Taq aquaticus*
- (c) *Thermus floral*
- (d) *Thermus aquaticus*

DNA analysis is done to

- (a) Diagnose viral infections
- (b) Identify criminals
- (c) Determine evolution
- (d) All of these

A method of DNA sequencing in which DNA threads are chemically cut into pieces of different sizes is

- (a) Sanger's method
- (b) Maxam-Gilbert method
- (c) Hamilton's method
- (d) Vortex method



15. Human genome is \_\_\_\_\_ times larger than any other genome sequenced so far  
(a) 45 (b) 35  
(c) 25 (d) 15
16. Organisms that have had a foreign gene inserted into them are  
(a) Transformed organisms (b) Transgenic organisms  
(c) Transfigured organisms (d) Recombinant organisms
17. Some transgenic bacteria produce a dipeptide sweetener called  
(a) Ultrasweet (b) Disweet  
(c) Monosweet (d) Neutrasweet
18. Transgenic plants are produced when foreign genes are introduced into  
(a) Mature plant embryo (b) Immature plant embryo  
(c) Roots (d) Leaves
19. Protoplasts are plant cells from which  
(a) Cell walls are removed (b) Nucleus is removed  
(c) New organelles are added (d) Vacuoles are taken out
20. A weed engineered to produce a biodegradable plastic in cell granules is  
(a) Mouse-cat cress (b) Mouse weed  
(c) Mouse-eared cress (d) None of these
21. An antibody made by soybeans can be used to treat  
(a) Herpes zoster (b) Sickle cell anemia  
(c) Measles (d) Genital herpes
22. In vortex method of transgenic animals gene is inserted  
(a) By hand (b) Into egg  
(c) Both by hands and into eggs (d) Is not applicable
23. For biotechnology products which is the preferable vehicle  
(a) Urine (b) Milk  
(c) Sweat (d) Hairs
24. Cumulus cells are those that  
(a) Remain with follicular cells after ovulation occurs  
(b) Form corpus luteum  
(c) Form lining of the ovary  
(d) Cling to the egg after ovulation occurs
25. Two methods for gene therapy are  
(a) In-vivo and ex-vitro (b) Ex-vivo and in-vivo  
(c) Both of these (d) None of these
26. In cystic fibrosis patient lacks a gene for the transmembrane carrier of the  
(a) Magnesium ion (b) Calcium ion  
(c) Cholesterol (d) Chloride ion
27. Plasmid do not carry gene for  
(a) Antibiotic resistance (b) Fertility  
(c) Growth (d) Both b and c
28. Full set of genes of an individual is called  
(a) Genotype (b) Genomic library  
(c) Genome pool (d) Genome
29. Substance used to terminate DNA at different points in Sanger's method is  
(a) Deoxyribonucleotide triphosphate (b) Dideoxyribonucleotide triphosphate  
(c) Deoxyribonucleotide triphosphate (d) Dideoxyribonucleoside triphosphate





## Chapter 23

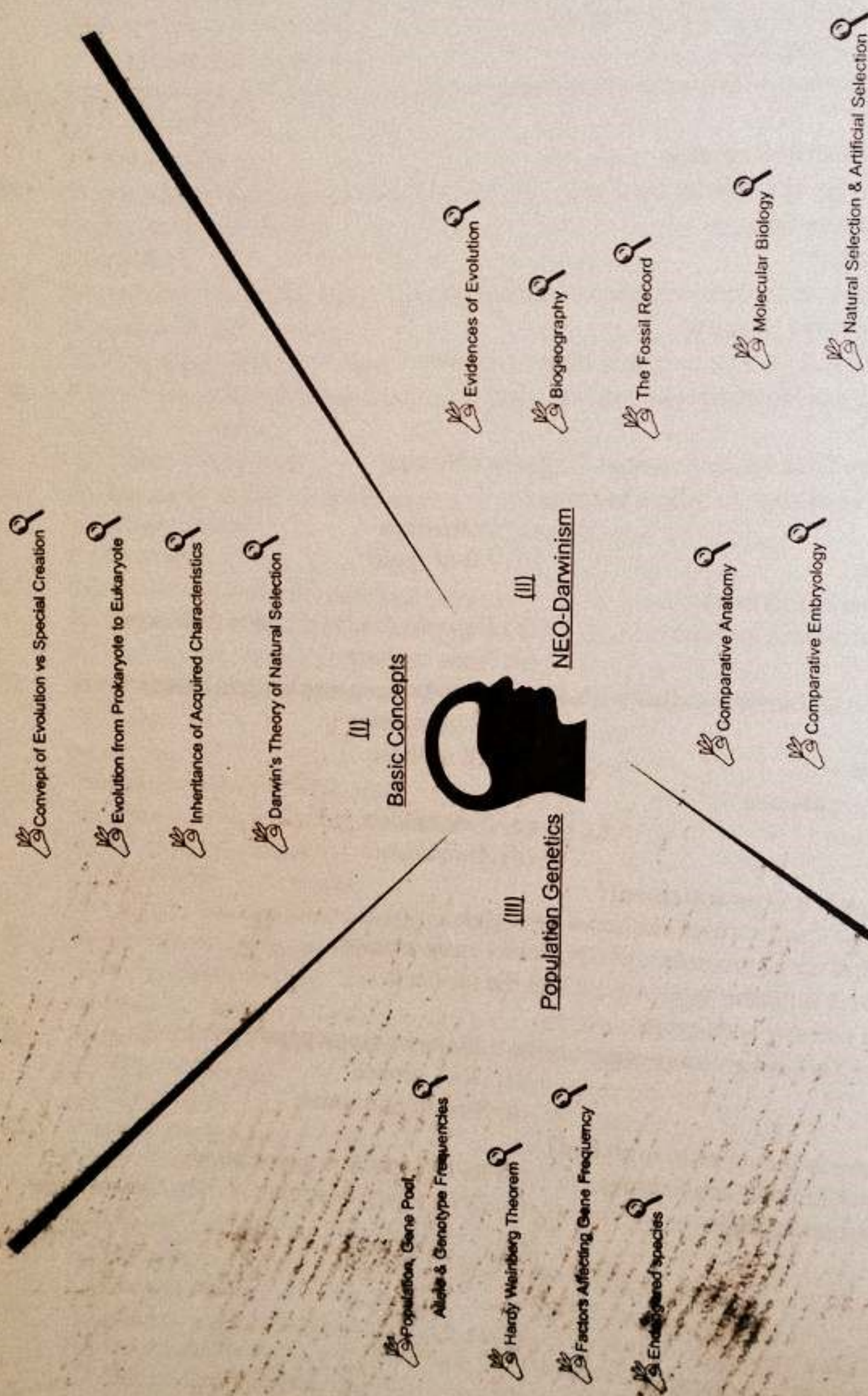
## Biotechnology

30. Transgenic bacteria are produced in large vats called  
 (a) Transducer (b) Biomultiplier  
 (c) Bioreactor (d) Culture media
31. Which of the following is correct about SCID?  
 (a) Common in children as well as in adults  
 (b) It is an immune disorder  
 (c) Is due to deficiency of adenosine deaminase  
 (d) Both b and c
32. Tissue culture does not involve  
 (a) Growth of tissue in artificial medium  
 (b) Asexual reproduction  
 (c) Use of meristem  
 (d) Use of generative nucleus in pollen culture
33. Plants are totipotent because  
 (a) Each cell has full genetic potential of the organism  
 (b) A single cell could become a complete plant  
 (c) Both a and b  
 (d) Because they have lesser potential for tissue culturing
34. Coconut milk contains the plant hormone  
 (a) Auxins (b) Cytokinins  
 (c) Gibberellins (d) All of these
35. Cell suspension cultures of  
 (a) *Cinchona* produces quinine (b) *Digitalis lanata* produce digitoxin  
 (c) Both a and b (d) None of these
36. A device that bombards a callus with DNA coated microscopic metal particles is  
 (a) DNA gun (b) DNA shooter  
 (c) Particle gun (d) All of these
37. Salt tolerant plants are  
 (a) *Cadabidopsis* (b) *Nemodopsis*  
 (c) *Saltdopsis* (d) *Arabidopsis*
38. Which of these is a true statement?  
 (a) Both plasmids and viruses can serve as vectors.  
 (b) Plasmids can carry recombinant DNA but viruses cannot  
 (c) Vectors carry only the foreign gene into the host cell.  
 (d) Only gene therapy uses vector.
39. Which of these would you not expect to be a biotechnology product?  
 (a) Vaccine (b) DNA probes  
 (c) Proteins (d) Steroid hormones
40. Which of these is incorrectly matched?  
 (a) Protoplast-Plant cell engineering (b) RFLPs-DNA fingerprinting  
 (c) DNA polymerase-PCR (d) DNA ligase-Mapping human chromosome



# Chapter 24

## EVOLUTION





Evolution refers to the process that has transformed life on earth from its earliest forms to vast diversity.

### CONCEPT OF EVOLUTION VS SPECIAL CREATION

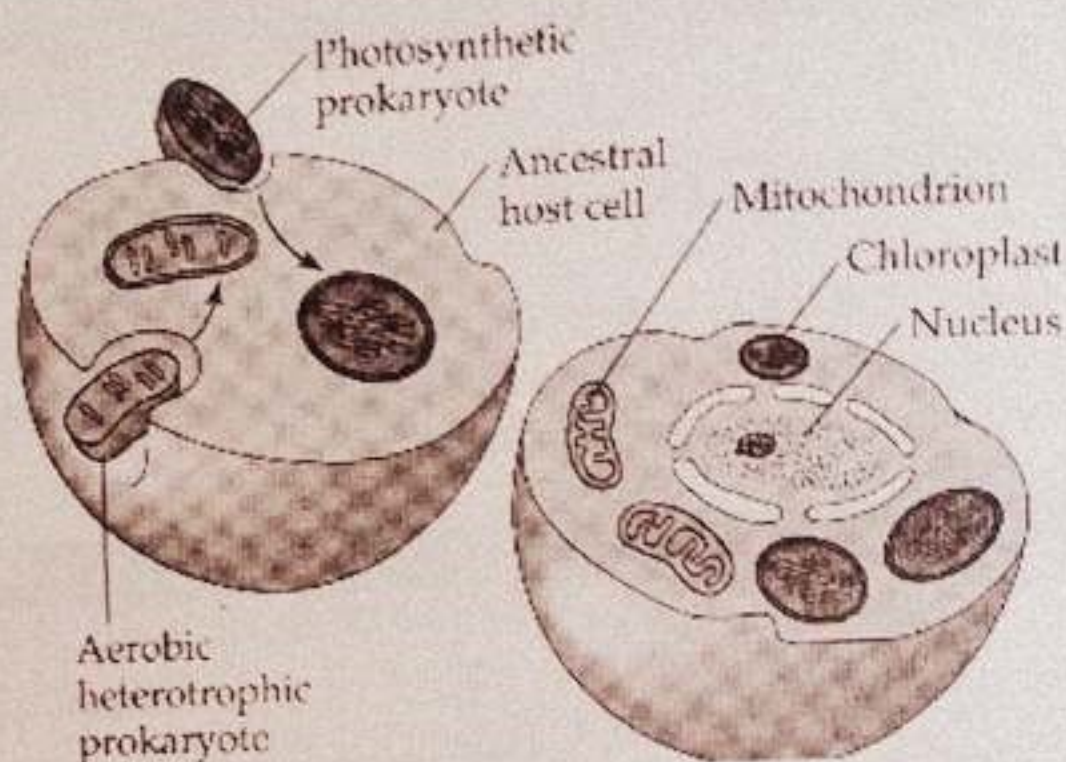
- According to theory of **special creation**, all living beings have been created by nature.
- According to theory of **natural selection**, all organisms evolved from others.
- Carlous Linnaeus** was believer of special creation.

SCIENTIST	LIFE SPAN	ACHIEVEMENTS
Linnaeus	1707-1778	Sought and found order in the diversity of life. He introduced binomial nomenclature for naming species.
Lamarck	1744-1829	Published his theory of evolution.
Malthus	1766-1834	Published essay on the 'Principle of Population'.
Cuvier	1769-1832	Contributed much to the science of Palaeontology and explained earth's history by catastrophism.
Lyell	1797-1875	Published principles of geology.
Darwin	1809-1882	i) Voyage of the Beagle. ii) Began his note books on the origin of species. iii) Wrote his essay on the origin of species.
Mendel	1822-1884	Published papers on inheritance.
Wallace	1823-1913	Sent his theory to Darwin.

### EVOLUTION FROM PROKARYOTES TO EUKARYOTES

- Hydrothermal vents** are under water hot springs from where origin of life might have begun.
- Prokaryote** (Archaeobacteria) are considered as **first life form**, which can survive at  $120^{\circ}\text{C}$ .
- First photosynthetic organisms probably used **hydrogen sulphide** as a source of hydrogen for reducing carbon dioxide to sugars.
- Prokaryotes are considered to be evolved **3.5 billion years** ago while eukaryotes **1.5 billion years** ago.
- Endosymbiont hypothesis** was presented by **Lynn Margulis** by which eukaryotes and organelles have been developed by some symbiotic relation with prokaryotes e.g. mitochondria, chloroplast, flagella etc.
- Mitochondria might have arisen through ingestion of aerobic bacteria.
- Flagella might have arisen through the ingestion of spirochetes.
- Chloroplasts might have arisen through the ingestion of cyanobacteria.
- Another hypothesis that explains the formation of organelles is cell membrane invagination hypothesis.





### INHERITANCE OF ACQUIRED CHARACTERS

- **Jean Baptiste Lamarck** (1744-1829) published his theory of evolution in 1809, the year Darwin was born.
- Two important points of *Lamarck's theory* are; use and disuse of organs and inheritance of acquired characters.
- According to Lamarck, inheritance of acquired characters means that the modifications an organism acquires during its lifetime can be passed along to its offspring

### DARWIN'S THEORY OF NATURAL SELECTION

- Darwin observed and collected thousands of specimens of diverse faunas and floras of South America.
- His main observations were about fauna and flora of Galapagos Islands where he collected 13 types of finches.
- **According to Darwin**, new species would arise from an ancestral form by the gradual accumulation of adaptations to different environments, separated from original habitat by geographical barriers. Over many generations, the two populations could become dissimilar enough to be designated as separate species
- In 1844 Darwin wrote a long essay on the origin of species and natural selection, his book *The origin of species* was published in 1859
- Darwin believed in **perceived unity in life** i.e. all organisms related through descent from some common ancestor that lived in the remote past.
- According to Darwin, history of life is like a tree, with multiple branching and rebranching from a common trunk all the way to the tips of the living twigs, symbolic of the current diversity of organisms.
- According to Darwin's theory  
Overproduction > Struggle for Existence > Survival of the Fittest/ Natural Selection > Evolution



### NEO-DARWINISM-THE MODERN EVOLUTIONARY SYNTHESIS

- It is comprehensive theory of evolution that was developed in 1930s when Mendelism and Darwinism were reconciled.
- Neo-Darwinism or modern synthesis* is called so because it has integrated discoveries and ideas from many different fields including paleontology, taxonomy, and biogeography and of course population genetics.

### EVIDENCES OF EVOLUTION

- Evolution leaves observable signs.
- Darwin's theory was mainly based on the evidence from geographical distribution of species and from the fossil record.

#### BIOGEOGRAPHY

- Biogeography* is geographical distribution of species.
- Islands have many species of plants and animals that are endemic but closely related to species of the nearest mainland or neighbouring island.
- Armadillos, the armored mammals live only in the America.

#### THE FOSSIL RECORD

- Fossils* are either the actual remains or traces of organisms that lived in ancient geological times.
- Most fossils are found in *sedimentary rocks*.
- Fossils provide visual record in a complete series showing the evolution of an organism.
- The oldest known fossils are of prokaryotes.
- They show chronological appearance of the different classes of organisms.

#### COMPARATIVE ANATOMY

- Comparative anatomy* deals with anatomical similarities between species grouped in the same taxonomic category.
- Similarity in characteristics resulting from common ancestry is known as *homology* and such anatomical signs of evolution are called *homologous structures* e.g. arms of man, forelimb of cat, flipper of whale and wings of bat and also the flower parts of a flowering plant.
- Homologous structures show *divergent evolution*.
- Analogous organs* are functionally alike but structurally different e.g. wings of bats, birds and insects etc. These are examples of convergent evolution.
- Vestigial organs* are historical remnants of structures that had important functions in ancestors but are no longer essential. These are the oldest homologous structures. For instance, the skeleton of whales and some snakes retain vestiges of the pelvis and leg bones of walking ancestors, vermiform appendix in carnivores, and ear muscles in man.

#### COMPARATIVE EMBRYOLOGY

- Evolution is a *remodelling process* in which ancestral structures that functioned in one capacity become modified as they take on new functions.
- Closely related organisms go through similar stages in their embryonic development





- Gills have modified into *Eustachian tubes* that connect the middle ear with the throat in humans.

### MOLECULAR BIOLOGY

- Molecular biology** is study of evolutionary relationships among species is reflected in their DNA and proteins i.e. in their gene and gene products.
- For example, a common genetic code brings evidence that all life is related.
- Cytochrome c, a respiratory protein is found in all aerobic species.



- \_\_\_\_\_ refers to the process that has transformed life on earth from its earliest forms to vast diversity.
- \_\_\_\_\_ are under water hot springs from where origin of life might have begun.
- \_\_\_\_\_, the armored mammals live only in the America.
- Homologous structures show \_\_\_\_\_ evolution.
- Gills have modified into \_\_\_\_\_ that connect the middle ear with the throat in humans.
- \_\_\_\_\_, a respiratory protein is found in all aerobic species.

### NATURAL SELECTION AND ARTIFICIAL SELECTION

- Artificial selection** involves breeding of domesticated plants and animals.
- Population** is a group of interbreeding individuals belonging to a particular species and sharing a common geographic area.
- Natural selection can amplify or diminish only those variations that are heritable.
- An example of natural selection is the evolution of antibiotic resistance in bacteria.

### POPULATION, GENE POOL, ALLELE AND GENOTYPE FRQUENCIES

- Species** is a group of populations that have the potential to interbreed in nature.
- The total aggregate of genes in a population at any one time is called the population's *gene pool*.
- If all members of a population are homozygous for the same allele, that allele is said to be *fixed* in the gene pool.
- More often there are two or more alleles for a gene each having relative frequency (population) in the gene pool.

Answers: (1) Evolution (2) Hydrothermal Vents (3) Armadillos (4) Divergent (5) Eustachian Tube (6) Cytochrome C



- According to Hardy Weinberg theorem, frequencies of alleles and genotypes in a population's gene pool remain constant over the generations unless acted upon by agents other than sexual recombination.
- Hardy-Weinberg equation** is used for calculating the frequencies of alleles and genotypes in populations at equilibrium
- If  $p+q=1$ , then  $1-p=q$ , or  $1-q=p$
- $p^2 + 2pq + q^2 = 1$

### FACTORS AFFECTING GENE FREQUENCY

Five factors affect the proportion of homozygotes and heterozygotes enough to produce significant deviations from the proportion.

FACTOR	DESCRIPTION
Mutation	The ultimate source of all changes; individual mutations occur so rarely that mutation alone does not change allele frequency much
Migration	A very potent agent of change, migration locally acts to prevent evolutionary changes by preventing populations that exchange members from diverging from one another. Emigration and immigration of members of a population, cause disturbance in the gene pool
Genetic drift	It is the change in frequency of alleles at a locus that occurs by chance. In small populations, such fluctuations may lead to the loss of particular alleles. This may occur in a small population when a few individual fail to reproduce and then genes are lost from the population.
Non-random mating	Inbreeding is the most common form; it does not alter allele frequency, but lessens the proportion of heterozygote individuals. Individuals with certain genotypes sometimes mate with one another more commonly than would be expected on a random basis. This is called non-random mating, causing the frequencies of particular genotypes to differ greatly from those predicted by the Hardy-Weinberg principle
Selection	Some individuals leave behind more progeny than others, and the rate at which they do so is affected by their inherited characteristics. This is called selection. Selection can be artificial selection or natural selection. In artificial selection, the breeders select for the desired characters. In natural selection, the environment plays this role, thus affecting the proportions of gene in a population.

### ENDANGERED SPECIES

- Tropical rain forests**, the most threatened areas on the earth have been reduced to 44% of their original extent.
- An **endangered species** is in imminent danger of extinction throughout its range.
- A **threatened species** is likely to become endangered in the near future.
- Endangered species of plants have been recorded to more than 500.

ENDANGERED SPECIES	THREATENED SPECIES
Cheetah, Asian lion, Indian rhino, Cheer pheasant, Crocodile, Gavial	Indus dolphin, Blackbuck, Common leopard, Great Indian bustard, Houbara bustard, White-headed duck, Marbled teal





1. \_\_\_\_\_ involves breeding of domesticated plants and animals.
2. If all members of a population are homozygous for the same allele, that allele is said to be \_\_\_\_\_ in the gene pool.
3. \_\_\_\_\_ is the change in frequency of alleles at a locus that occurs by chance.
4. A \_\_\_\_\_ species is likely to become endangered in the near future.
5. Endangered species of plants have been recorded to more than \_\_\_\_\_.

## VALUES

Property	Value
Tolerable temperature for Archeobacteria	120°C
Establishment of ozone layer	420 million years ago
Origin of prokaryote (first life form)	3.5 billion years ago
Origin of first eukaryote	1.5 billion years ago
Number of types of finches observed by Darwin on Galapagos island	13
Reduction in tropical rain forest	44%
Reduction in forest coverage in Ecuador	95%
Endangered species of plants recorded so far	500

Answers: (1) Artificial Selection (2) Fixed (3) Genetic Drift (4) Threatened (5) 500



## PRACTICE EXERCISE



The process that has transformed life on earth from its earliest forms to vast diversity is

- (a) Mutation
- (b) Evolution
- (c) Migration
- (d) Genetic drift

Carolus Linnaeus was believer of

- (a) Special creation
- (b) Natural selection
- (c) Catastrophism
- (d) Inheritance of acquired characters

Which scientist does not match his achievements

- (a) Lamarck published his theory of evolution
- (b) Lyell published principles of geology
- (c) Malthus published essay on principle of population
- (d) Cuvier published papers on inheritance

Archaeobacteria can survive at

- (a) 150°C
- (b) 300°C
- (c) 120°C
- (d) 200°C

What was the source of hydrogen for first photosynthetic organisms?

- (a) Water
- (b) Hydrogen present in soil
- (c) Hydrogen sulphate
- (d) Hydrogen sulphide

Prokaryotes are considered to be evolved

- (a) 3.5 billion years ago
- (b) 1.5 billion years ago
- (c) 4.5 billion years ago
- (d) 1000 million years ago

Flagella might have arisen through the ingestion of

- (a) Cyano-bacteria
- (b) Spirochetes
- (c) Chlamydomonas
- (d) Paramecium

Important point/s of Lamarck's theory

- (a) Use and disuse of organs
- (b) Inheritance of acquired characters
- (c) Natural selection
- (d) Both a and b

Who developed a theory of natural selection essentially identical to Darwin's

- (a) Hardy-Weinberg
- (b) Alfred Wallace
- (c) Malthus
- (d) Lyell

Neo-Darwinism has integrated discoveries and ideas from

- (a) Taxonomy
- (b) Paleontology
- (c) Genetics
- (d) All of these

The actual remains or traces of organisms that lived in ancient geological times

- (a) Vestigial remains
- (b) Fossils
- (c) Fuel
- (d) None of these

Most fossils are found in the

- (a) Metamorphic rocks
- (b) Soil
- (c) Sedimentary rocks
- (d) Volcanic mountains

Which statement is incorrect?

- (a) Homologous organs are functionally different but structurally alike
- (b) Analogous organs are functionally different but structurally alike
- (c) Examples of homologous structures are arms of man, forelimb of cat, flipper of whale
- (d) Examples of analogous structures are wings of bats, birds and insects





14. Analogous organs show
  - (a) Convergent evolution
  - (b) Divergent evolution
  - (c) Straight evolution
  - (d) Zig-zag evolution
15. In humans gill pouches have modified into
  - (a) Nose
  - (b) Ear
  - (c) Eustachian tubes
  - (d) External ear
16. A group of interbreeding individuals belonging to a particular species and sharing a common geographic area is called
  - (a) Community
  - (b) Family
  - (c) Population
  - (d) Race
17. Natural selection can amplify or diminish variations that are
  - (a) Non heritable
  - (b) Heritable
  - (c) Both heritable and non heritable
  - (d) Acquired
18. Adaptations that an organism acquires by its own actions are
  - (a) Heritable
  - (b) Not heritable
  - (c) Can be made heritable through some modifications
  - (d) Both heritable and not heritable
19. A group of populations that have the potential to interbreed in nature is
  - (a) Genus
  - (b) Family
  - (c) Species
  - (d) Community
20. The total aggregate of genes in a population at any one time is called population's
  - (a) Genome
  - (b) Genomic library
  - (c) Genetic group
  - (d) Gene pool
21. If all members of a population are homozygous for the same allele, that allele is said to be
  - (a) Fixed in gene pool
  - (b) Mobile in gene pool
  - (c) Random in gene pool
  - (d) Stationary in gene pool
22. According to Hardy-Weinberg theorem, frequencies of alleles and genotypes in a population's gene pool remain
  - (a) Mobile
  - (b) Stationary
  - (c) Constant
  - (d) Constant unless acted upon by agents other than sexual recombination
23. The ultimate source of all changes is
  - (a) Mutation
  - (b) Migration
  - (c) Genetic drift
  - (d) Selection
24. Disturbance in the gene pool is created by
  - (a) Emigration
  - (b) Immigration
  - (c) Both a and b
  - (d) Panmigration
25. Change in the frequency of alleles at a locus that occurs by chance is
  - (a) Mutation
  - (b) Selection
  - (c) Non-random mating
  - (d) Genetic drift
26. Which of the following organs serve no apparent purpose
  - (a) Vestigial organs
  - (b) Non vestigial organs
  - (c) Homologous organs
  - (d) Analogous organs



## Chapter 24

## Evolution

Which of the following processes had resulted in the production of different breeds of domestic dogs and pigeons?

- (a) Natural selection
- (b) Cross breeding
- (c) Artificial selection
- (d) Self breeding

Which of the following is not vestigial organ of man?

- (a) Appendix
- (b) Coccyx
- (c) Nictitating membrane
- (d) None of these

Concept of evolution was first presented by

- (a) Aristotle
- (b) Lamarck
- (c) Darwin
- (d) Wallace

If we consider Hardy-Weinberg law, then following is incorrect in its sense

- (a) Mutations cause changes in genetic frequency
- (b) Migration changes allelic frequency
- (c) There should not be selection
- (d) Non-random mating will reduce chances of evolution









### INTRODUCTION

- The term *ecology* comes from the Greek words '*oikos*' meaning 'the family household' and '*logy*' meaning 'study of'.
- The term ecology was first used by German zoologist *Ernst Haeckel*. He defined it as the study of the relationship of animals (organisms) to their environment.
- Relationship includes interactions with the physical world and with members of other species and the same species.

### ECOSYSTEM

- The major unit of ecology is the *ecosystem*.
- The '*eco*' part of the word is related to the environment and the '*system*' part means a collection of related parts that function as a unit.
- Ecosystem consists of two basic interacting components, *biotic* (living) and *abiotic* (physical).
- All populations within an ecosystem interconnected to one another are known as a *community*.
- Major regional ecological community of plants and animals forms *biomes*.
- Combination of all biomes of earth is called *planetary ecosystem*.
- There are six major terrestrial biomes.

### BIOSPHERE

- *Biosphere* is a thin layer of earth in which all living organisms exist.
- Biosphere is spread out over the surface of earth extending about 8-10km to the upper reaches of atmosphere and also the same distance into the depths of ocean.
- The actual location of place where an organism lives is called its *habitat*.
- In 1917, *Joseph Grinnell*, an American ornithologist, first proposed the term niche in ecology.
- The ultimate distributional unit within which a species is restrained by the limitations of its physical structure and its physiology is called *niche*.
- *Charles Eton* considered the niche the basic role of an organism in the community. He defined the niche, as the species' occupation.

### AUTECOLOGY

Study of a single population's relationship to its environment is called *autecology*.

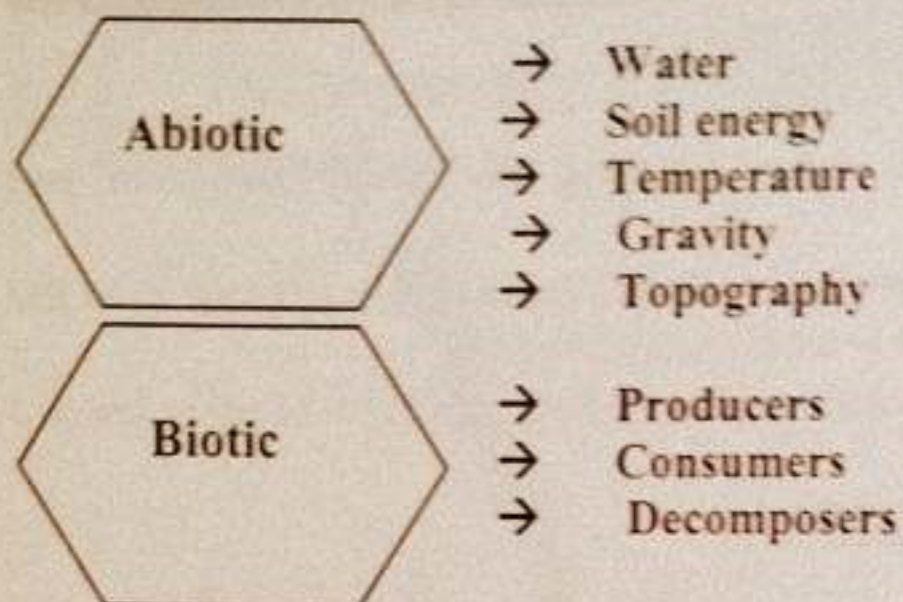
### SYNECOLOGY

Study of different communities to environment is called *synecology* or *community ecology*.

### COMPONENTS OF ECOSYSTEM

- *Biotic components* include all living organisms supported by biosphere.
- *Abiotic components* include non-living components i.e. atmosphere, Hydrosphere, lithosphere.



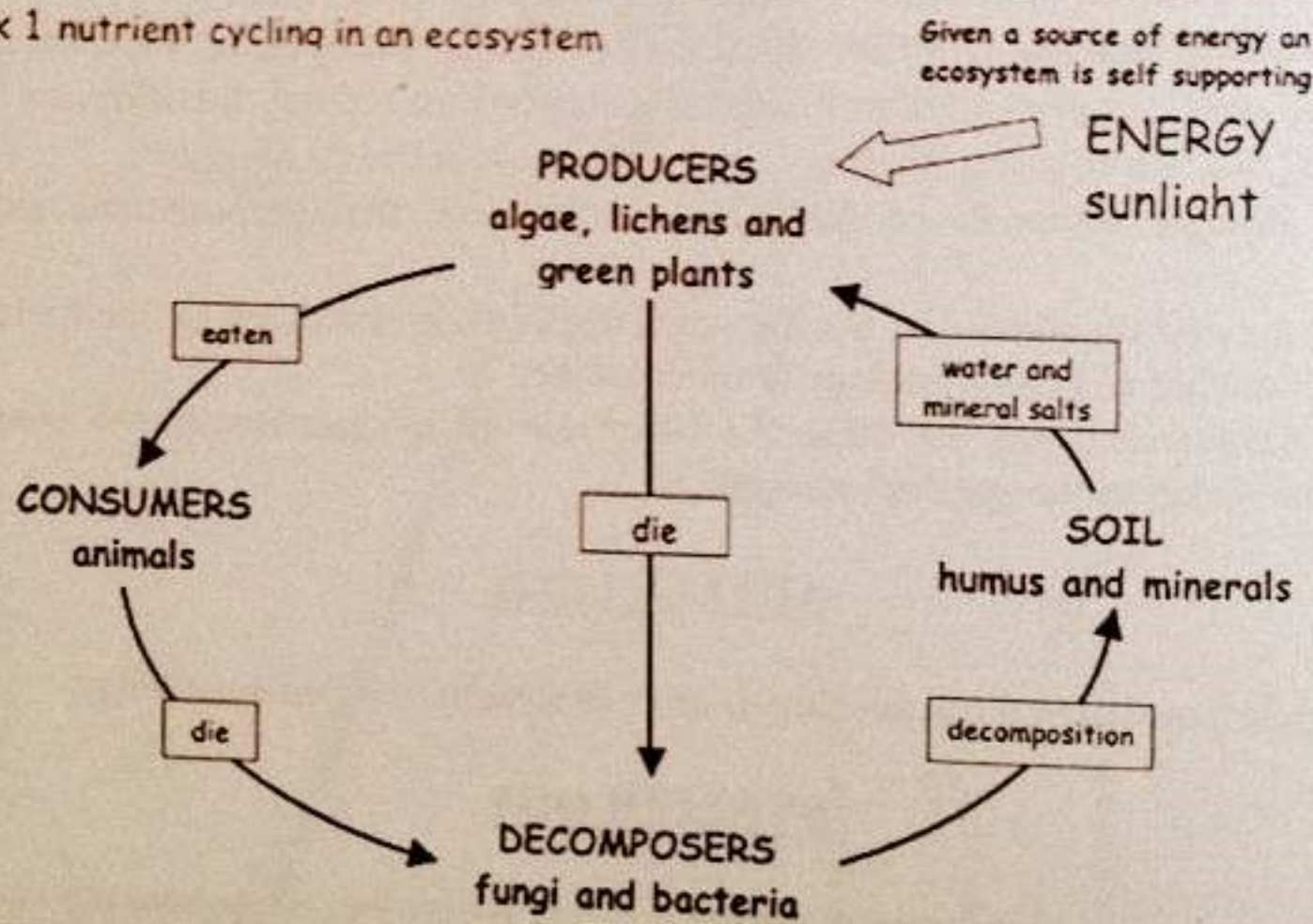


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### PROCESSES IN ECOSYSTEM AND INTERACTION BETWEEN BIOTIC AND ABIOTIC COMPONENTS.

COMPONENTS	DESCRIPTION
Producers	They are green photosynthetic plants, capture and bring light energy into the ecosystem. They are autotrophic organisms
Consumers	All organisms mainly animals which obtain energy directly or indirectly from the producers as ready-made organic food. They are heterotrophic organisms
Decomposers	Fungi and bacteria which obtain their energy from dead and decaying plants and animals. They release chemical elements as ions

Box 1 nutrient cycling in an ecosystem



All individuals of the same species = a population. The populations together = the community. The community + the non-living part of the environment = the ecosystem



FOOD CHAIN

- All animals depend on plants for their food constituting *food chain*

- *Simple food chain:*

Eagle → Blue bird → Caterpillar → Grass

FOOD WEB

- Combination of many food chains is called *food web*.
- Food webs consist of **3-5 trophic levels** e.g. T1 is producers, T2---primary consumers, T3---secondary consumers, T4---tertiary consumers

SUCCESSION

- **Succession** is a change in community and its non living environment over a period of time.
- Succession begins by a few hardy invaders called *pioneers*.
- Diverse and stable community at the end is called *climax community*.
- Succession in an ecosystem from bare rock sand or clear glacial pool where there is no trace of previous life is called *primary succession*.
- During *secondary succession*, a new ecosystem develops after an existing ecosystem is disturbed by fire or an abandoned form field.
- Primary succession starting in a pond is called *hydrosere* and that on a dry soil or habitat is called *xerosere*. Plants growing in xeric conditions are called *xerophytes*, which are able to withstand prolonged periods of water storage. Succulent plants like cacti have water stored in large parenchyma tissue

XEROSERE STAGE	DESCRIPTION
Crustose lichen stage	Crustose means crust on the substratum. Special types of lichens get impacted in the form of crust. They are dormant
Foliage lichen stage	In it lichens are just like crumpled leaves attached at one point. Produces shade to the crustose lichens as a result of which their growth is reduced. Area becomes rough with more fishers and depressions. eg <i>Dermatocarpon, permellia</i>
Moss stage	Mosses like <i>polytrichum, tortula</i> etc. They compete with lichens for water and penetrate deeper into the soil add more humus
Herbaceous stage	They establish due to more availability of moisture, humus, soil
Shrub stage	Shrubby plants start growing and shadowing herbaceous plants which die and add more humus
Climax forests	Woody plants develop due to improved soil. They dominate and this stage remains same if nothing changes in the environment to upset the balance





### PREDATION AND ITS SIGNIFICANCE

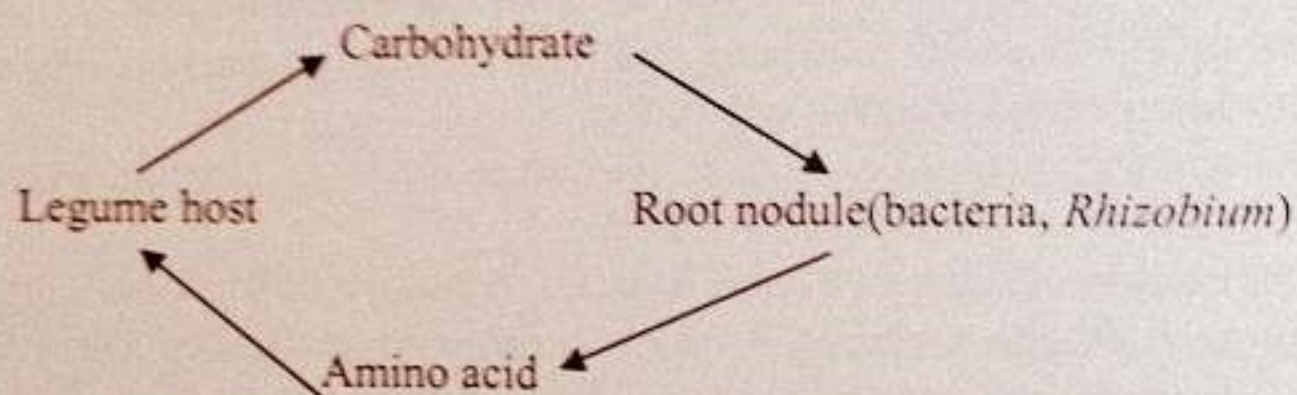
- An animal that preys on other animals is a *predator* while an animal which is caught and eaten is the *prey*.
- Relation between predator and prey is called *predation*.

### PARASITISM AND ITS SIGNIFICANCE

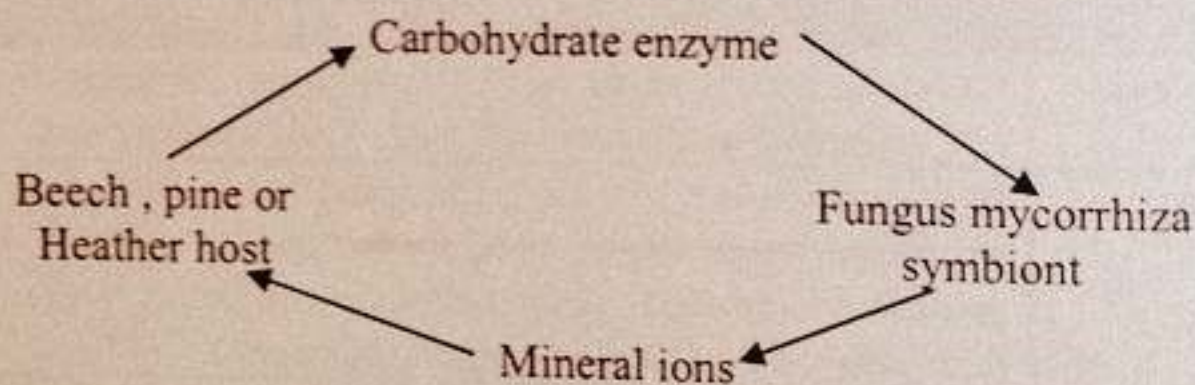
- *Parasitism* is an association between a host and a parasite.
- Diseases in living organism which caused by parasites are called *infestations*.
- Parasites may be *ectoparasites* (living outside the body of the host) and *endoparasites* (living inside the body of the host).

### SYMBIOSIS

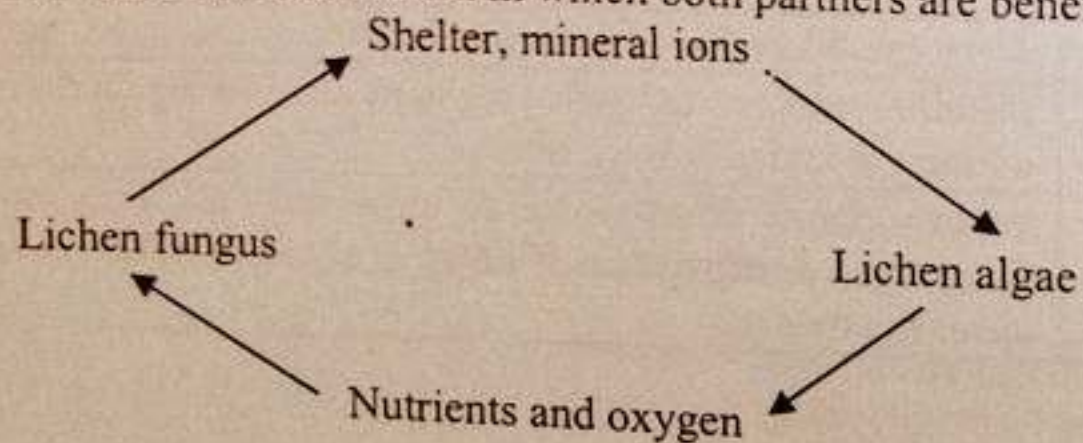
- *Symbiosis* is an association between two organisms which brings benefit to both organisms.
- Legume plants are the hosts to symbiont bacteria which inhabit the roots forming *root nodules*.



- *Mycorrhiza* is an association between the roots of plants growing in acid soil and certain fungi. Host is pine, beech or heather.



- *Mutualism* is a symbiotic association in which both partners are benefited.





- *Lichens* is a dual organism composed of symbiotic association of an alga living within a fungus mycelium

### COMMENSALISM

- Such type of symbiotic relation in which only one organism is benefited is called *commensalism*.
- *Sharks* may have small fish called *remoras* attached to them

### GRAZING

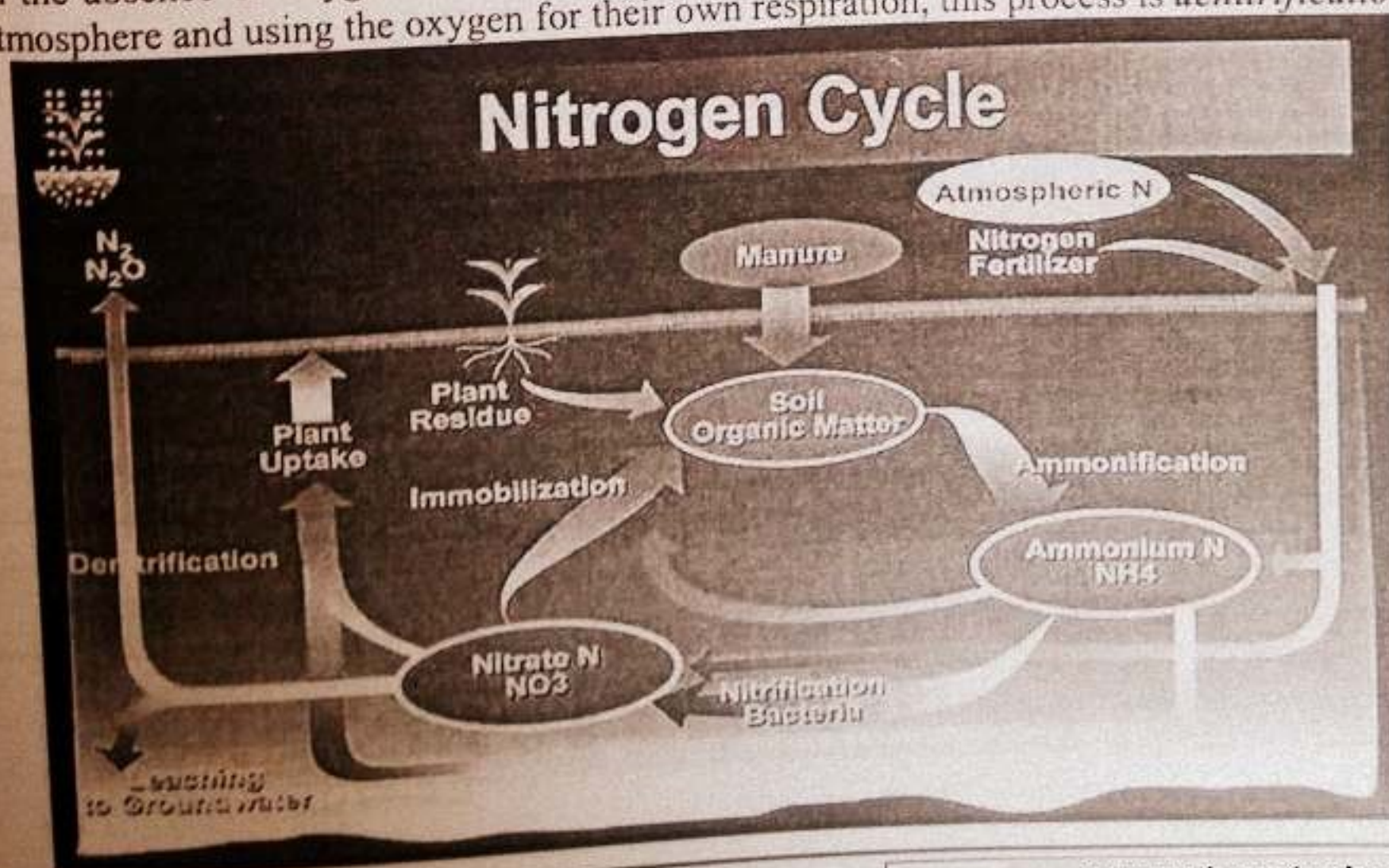
- Feeding on grasses is called *grazing* and such animals are called *grazers*.
- Grasses are more resistant than herbaceous plants.
- Final result of *over-grazing* is totally barren land

### BIOGEOCHEMICAL CYCLES

- The chemical elements essential for life in living organisms are called *biogenic elements* or *nutrient elements*.
- *Macronutrients* are elements required by organism in large amount and *micronutrients* are elements required by organism in small quantity or in trace amount
- Circulation of nutrient elements between living organism and their environment is called *biogeochemical cycle*.

#### Nitrogen cycle

- Chief reservoir of nitrogen is atmosphere containing about 78% of it.
- Three principal stages of nitrogen cycle are ammonification, nitrification and assimilation.
- Release of excess of ammonia or ammonium ions is known as *ammonification*
- Oxidation of ammonia or ammonium ions by bacteria in soil is called *nitrification*
- Conversion of ammonium to nitrate and then again back to ammonium within the plant cell is called *assimilation*
- In the absence of oxygen soil bacteria break down nitrates releasing nitrogen back into the atmosphere and using the oxygen for their own respiration, this process is *denitrification*







# FLOW OF ENERGY IN FOOD CHAIN OF AN ECOSYSTEM

- The total amount of energy fixed by plants is *gross primary production*.
- Gross primary production minus respiratory loss is net primary production. It is plant *biomass*.
- About 1% of the total energy from sun is trapped by the producers in an ecosystem.



- The term ecology was first used by German zoologist \_\_\_\_\_.
- The major unit of ecology is the \_\_\_\_\_.
- \_\_\_\_\_ considered the niche the basic role of an organism in the community.
- Combination of many food chains is called \_\_\_\_\_.
- Succession begins by a few hardy invaders called \_\_\_\_\_.
- Relation between predator and prey is called \_\_\_\_\_.
- Such type of symbiotic relation in which only one organism is benefited is called \_\_\_\_\_.
- Circulation of nutrient elements between living organism and their environment is called \_\_\_\_\_.
- Oxidation of ammonia or ammonium ions by bacteria in soil is called \_\_\_\_\_.
- The total amount of energy fixed by plants is \_\_\_\_\_.

## VALUES

Property	Value
Major terrestrial biomes	6
Levels of integration in community	3
Extent of biosphere	16-20 Km
Number of trophic levels in food chains & food webs	3-5
Percentage of nitrogen in atmosphere	78%
Solar energy trapped by producers in ecosystem	1%
Amount of energy lost between two trophic levels	80-90%

Answers: (1) Ernst Haeckel (2) Ecosystem (3) Charles Elton (4) Food Web (5) Pioneers (6) Predation (7) Commensalism (8) Biogeochemical Cycle (9) Nitrification (10) Gross Primary Production





## PRACTICE EXERCISE

 25 mins  
Time Yourself

1. Study of relationship of organisms to their environment is
  - (a) Ecology
  - (b) Palaeontology
  - (c) Geology
  - (d) None of these
2. All populations within an ecosystem interconnected to one another are known as
  - (a) Species
  - (b) Family
  - (c) Community
  - (d) Biomes
3. Major regional ecological community of plants and animals forms
  - (a) Biosphere
  - (b) Biomass
  - (c) Biomes
  - (d) Bioecosystem
4. The actual location or place where an organism lives is
  - (a) Environment
  - (b) Biosphere
  - (c) Biomass
  - (d) Habitat
5. The role a species plays in a community including behavior and influence is
  - (a) Niche
  - (b) Niche
  - (c) Autecology
  - (d) Profession
6. Study of a single population's relationship to its environment is called
  - (a) Ecology
  - (b) Synecology
  - (c) Autecology
  - (d) Niche
7. The biosphere covers about
  - (a) 8-10 km
  - (b) 5-10 km
  - (c) 15-30 km
  - (d) 16-20 km
8. Abiotic components include
  - (a) Atmosphere
  - (b) Hydrosphere
  - (c) Lithosphere
  - (d) All of these
9. Which statement is true?
  - (a) Producers are heterotrophic organisms
  - (b) Consumers are autotrophic organisms
  - (c) Fungi and bacteria are decomposers
  - (d) Consumers release chemical elements as ions
10. Sequence of changes in community and its non-living environment over a period of time is
  - (a) Niche
  - (b) Succession
  - (c) Alterations
  - (d) Neo-ecology
11. Plants growing in xeric conditions are called
  - (a) Spherophytes
  - (b) Mesophytes
  - (c) Xerophytes
  - (d) Teridophytes
12. Lichen and algae form
  - (a) Climax community
  - (b) Pioneers community
  - (c) Initiator community
  - (d) Seral community
13. Diverse and stable community at the end of succession is
  - (a) Climax community
  - (b) Pioneers community
  - (c) Top community
  - (d) Stable community





14. **Secondary succession starts from**
  - (a) A bare rock sand
  - (b) Clear glacial pool
  - (c) From remains of previous ecosystem
  - (d) Fire
15. **Hydrosere is**
  - (a) Secondary succession starting in a pond
  - (b) Primary succession starting in a pond
  - (c) Primary succession starting on a dry soil
  - (d) All of these
16. **Mosses are**
  - (a) *Dermatocarpon*
  - (b) *Permelia*
  - (c) *Tortula*
  - (d) Both b and c
17. **Woody forests form the**
  - (a) Pioneers community
  - (b) Climax community
  - (c) Top community
  - (d) Transient community
18. **Disease in living organisms caused by parasites is called**
  - (a) Parasitism
  - (b) Infestation
  - (c) Predation
  - (d) Infection
19. **Legume plants are the hosts to**
  - (a) Rhizobium
  - (b) Mycorrhiza
  - (c) Lichen
  - (d) Algae
20. **A dual organism composed of symbiotic association of an alga living within a fungus mycelium is**
  - (a) Mycorrhiza
  - (b) Rhizobium
  - (c) Lichen
  - (d) Legume
21. **Symbiotic relationship in which only one organism is benefited is**
  - (a) Symbiosis
  - (b) Commensalism
  - (c) Mutualism
  - (d) Unism
22. **Sharks may have small fish attached to them called**
  - (a) Rumors
  - (b) Romas
  - (c) Romosis
  - (d) Remoras
23. **Over grazing leads to**
  - (a) Good pastured lands
  - (b) Rocky areas
  - (c) Totally barren lands
  - (d) Salinity
24. **Nitrogen constitutes about \_\_\_\_\_ % of atmosphere**
  - (a) 58%
  - (b) 25%
  - (c) 10%
  - (d) 78%
25. **Oxidation of ammonia or ammonium ions by bacteria in soil is called**
  - (a) Nitrification
  - (b) Ammonification
  - (c) Assimilation
  - (d) Denitrification
26. **Gross primary production is**
  - (a) Amount of energy fixed by small plants
  - (b) Amount of energy fixed by large plants
  - (c) Total amount of energy fixed by all plants
  - (d) Primary production minus respiratory loss
27. **Plant biomass is**
  - (a) Gross primary production
  - (b) Net primary production
  - (c) Gross primary production minus respiratory loss
  - (d) Both b and c



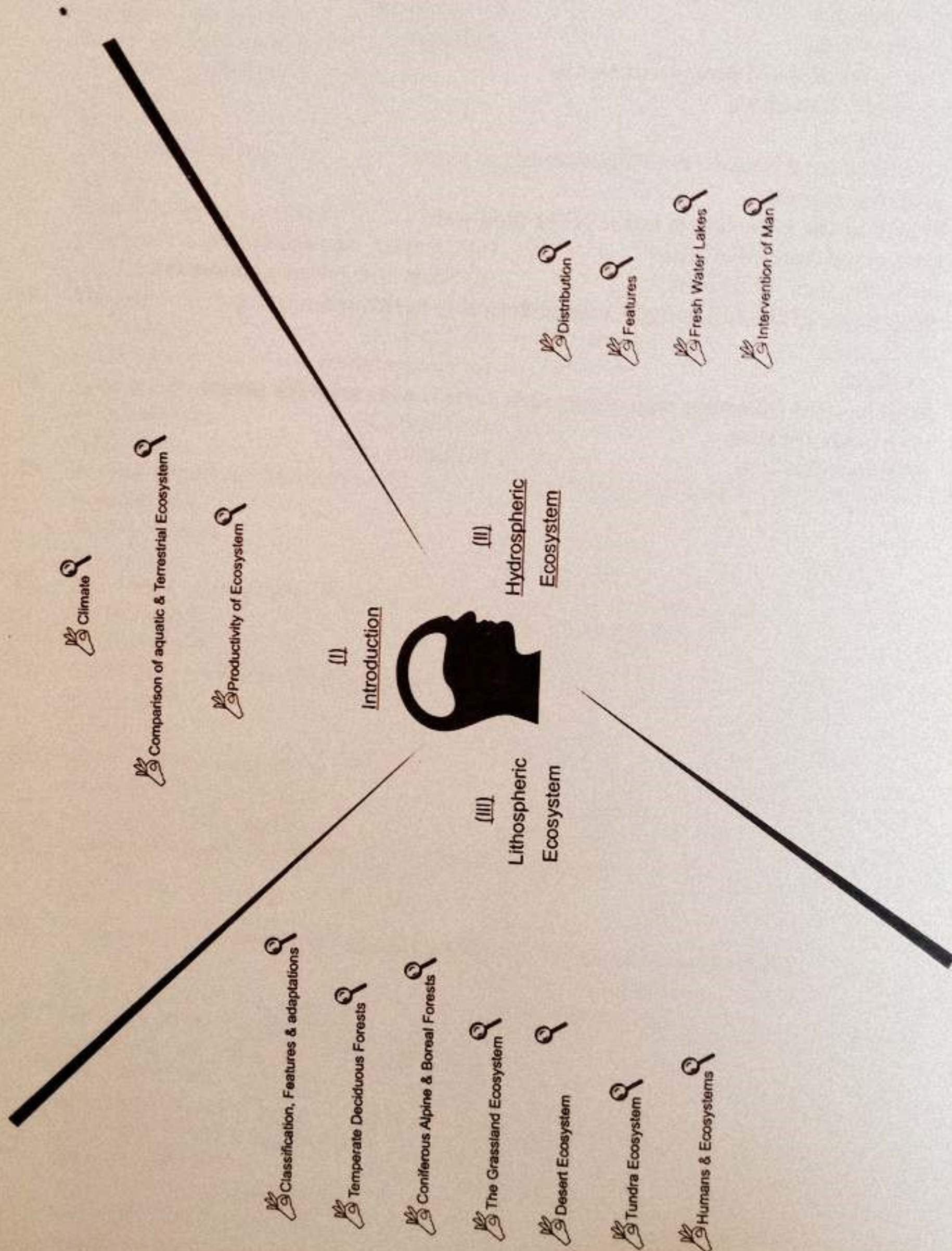


28. Total solar energy trapped by the producers in an ecosystem is  
(a) 95% (b) 20%  
(c) 78% (d) 1%
29. The major unit of ecology is  
(a) Population (b) Community  
(c) Ecosystem (d) Biome
30. 'Eco' part of word ecosystem means  
(a) Family household  
(b) Study of  
(c) Collection of related parts that function as a unit  
(d) Environment
31. Which of the following is not true for food web?  
(a) Formed from food chain (b) Complex than food chain  
(c) Stable than food chain (d) Starts with primary consumers
32. Which one of the following is more tolerant to herbivore  
(a) Grasses (b) Trees  
(c) Herbs (d) None of these
33. Which of the following step of nitrogen cycle is not useful for plants  
(a) Ammonification (b) Nitrification  
(c) Denitrification (d) Both a and c



# Chapter 26

## SOME MAJOR ECOSYSTEM





CLIMATE

- **Weather** refers to short-term fluctuations in temperature, cloud cover, wind and precipitation over periods of hours or days.
- **Climate** refers to overall patterns of weather that prevail from year to year even century to century in a particular region.

AQUATIC OR HYDROSPHERIC ECOSYSTEM

- **Hydrospheric ecosystem** is a system in water where living and non-living components exchange material and transfer of energy also takes place within water.
- **Salt-water ecosystem** covers about 71% earth surface.
- **Fresh water ecosystem** covers less than 1% of earth surface.
- Some important properties of aquatic ecosystem:
  - Its **temperature** is more moderate to support life
  - At the depth a little **light** is left to power photosynthesis
  - Abundant **water** with appropriate temperature

**Productivity of Aquatic Ecosystem**

- **Productivity** of an ecosystem can be indicated by consumption of  $\text{CO}_2$  and evolve of oxygen in the process of photosynthesis.
- Productivity of aquatic ecosystem is **determined by** light and nutrients, it also varies from zone to zone

FRESH WATER LAKES

Lake Ecosystem is divided into three zones i.e. littoral zone, limnetic zone and profundal zone.

ZONES	LIGHT AND NUTRIENTS	INHABITANTS
<b>LITTORAL ZONE (Near-shore)</b>	As water is shallow so there is abundant light, Anchorage, adequate nutrients	Water lilies, submerged vascular plants and algae at deepest regions. Living among anchored plants are microscopic organisms called <b>plankton</b> <b>Phytoplankton:</b> photosynthetic protista, bacteria, algae <b>Zooplankton:</b> protozoa, crustaceans Littoral invertebrate animals are small crustaceans, insect larvae, snails, flatworms, hydra and vertebrates are frogs, aquatic snakes, turtles
<b>LIMNETIC ZONE</b>	Plants are unable to anchor at bottom but enough light penetrates to support photosynthesis	Phytoplankton: cyanobacteria (blue green algae) Protozoa, small crustaceans, fishes
<b>PROFUNDAL ZONE</b>	Light insufficient to support photosynthesis, organisms are nourished by detritus and incoming sediment	Snails, insect larvae, bacteria, fungi and fishes



INTERVENTION OF MAN IN AQUATIC ECOSYSTEM

- **Eutrophication** is enrichment of natural ecosystem due to activity of humans.
- In polluted Lake Most of the trophic levels like fish are eliminated and bacteria and blue green algae dominate the community.

TERRESTRIAL OR LITHOSPHERIC ECOSYSTEM

- Ecosystem present on land or soil is called *terrestrial or lithospheric ecosystem*.

ADAPTATIONS FOR TERRESTRIAL ECOSYSTEM:

**Supporting Tissues**

Xylem and phloem in plants and skeleton in animals.

**Conservation Of Water**

In plants temperature regulation takes place by developing bark and in animals by skin.

MAJOR TERRESTRIAL ECOSYSTEM	LOCATION IN PAKISTAN
Temperate Deciduous Forests	Shogran & Neelum Valley
Coniferous Alpine & Boreal Forests	Northern mountains of Kaghan, Malam Jabba (Swat), Dir & Chilas
Grassland Ecosystem	Gilgit & Kashmir, Waziristan, Lower Chitral & North Kallat
Desert Ecosystem	Mianwali, Bakhar, Fort Abbas, Bahawal Nagar, Yazman, Bahawal Pur, Khan Pur, Rahim Yar Khan & Sind
Tundra Ecosystem	Mountains of Karakoram & Hindukush

**Temperate Deciduous Forests**

- **Average rain fall** is 750-1500mm.
- **Temperature range** is 4-30 C
- **Soil** is grayish brown, fertile and rich

**Coniferous Alpine And Boreal Forests**

- Northern coniferous forests are also called **Taiga**.
- Coniferous forest located at high altitude are called **alpine** while coniferous forest located at high latitude are called **boreal**.
- **Winters** are longer and colder and growing season is shorter
- There are long severe **winters**.
- **Temperatures** is below freezing upto 10 C

**Grass Land Ecosystem**

- Grasslands present in temperate climates are called **prairies**. These do not have woody plants
- Grassland in tropic climates with woody trees is called **savanna**.
- **Annual rainfall** in grassland is 250-750mm, usually face severe droughts
- Tall grasses form the **1<sup>st</sup> layer**, mid high grasses form the **2<sup>nd</sup> layer**, **3<sup>rd</sup> layer** is formed by short grasses, forbs and warfare species with mosses and lichens



- Upper *soil* layer is moist but deeper layers are dry, soil is basically impermeable with excessive salinity
- In temperate grassland, rate of *primary production* is about  $700-1500\text{g/m}^2$  annually and in sub-humid tropical grassland it is more than  $4000\text{g/m}^2$
- *Desertification* is common by which lands are converted into deserts due to human activities. Over grazing results in soil erosion

### Desert Ecosystem

- Widely spaced *vegetation* and large areas of bare ground
- *Annual rainfall* in deserts is less than  $250-500\text{mm}$ .
- The perennial plants are bushes or cacti with large shallow root system. They are covered with waxy coating

### Tundra Ecosystem

- Treeless tundra of high latitude between taiga and polar ice caps is called *arctic tundra*.
- Tundra is perhaps the most fragile of all biomes because of its short growing season

### LITHOSPHERIC EXOSYSTEMS

Feature	Temperate Deciduous Forests	Coniferous Forests	Grassland	Desert	Tundra
Location in Pakistan	Shogran & Neelum valley	Northern mountains of Kaghan, Malam Jabba (Swat), Dir & Chilas	Gilgit & Kashmir, Waziristan, Lower Chitral & North kallat	Mianwali, Bhakkar, (Thal) Fort Abbas, Bahawal Pur, Bahawal Nagar, Yazman, Khan Pur, Rahim Yar Khan (Cholistan), Sind (Thar)	Mountains of Kara Koram and Hindukush
Location in World	India, Southeast Asia, Eastern North America, Europe, China, Australia, Japan, North & South America.	Eurasia (Europe & Asia), North America, Canada.	Centre of Eurasia continents, Prairies of North America, Pampas of Argentina	Every continent around $20-30$ north and south latitude.	Polar ice-caps, Mountains of Koh Hindu Kush & Kara Koram, Northern North America, Northern Europe, Siberia.
Annual Rain Fall	$750-1500\text{mm}$ , not constant		$250-750\text{mm}$ ( $10-30$ inches). $1500$	Less than $250-500\text{mm}$ ( $25-50\text{cm}$ , $10-20$ )	



	slightly farther away from equator		mm (60 inches) in tropical & subtropical grassland	inches), or not at all.	
Temperature	Moderate ranging from 4C-30C	Ranges from below freezing point to 10C			
Seasons	Pronounced wet & dry season with distinct summer & winter.	Harsher conditions, winters longer & colder, growing season short, summer is too short.	Annual rainfall & conditions midway between forest & desert.	Widely spaced or no vegetation & large area of bare grounds.	
Soil condition	Grayish brown, very fertile & rich in organic matter with maximum holding capacity	Constant cover of snow	Limited soil moisture due to low precipitation & high evaporation, upper rooted soil layer moist while deeper dry. Impermeable with excessive salinity.		
Plants	<ul style="list-style-type: none"> <li>• <b>Dominant plants:</b> Taxus baccata, Pinus wallichiana, Berberis lyceum.</li> <li>• Many herbs &amp; shrubs with height of 5m.</li> <li>• Grasses, ferns &amp;</li> </ul>	Pinus wallichiana, Pinus roxburgii, Abies pindrow, Picea smithiana, Cedrus deodara. Northern coniferous forests are called <b>taiga</b> . Coniferous forests of high altitude	Graminoids (grasses & grass like plants), certain forbs (e.g. composites, legumes & others). Grassland in temperate climate without woody plants is called <b>prairies</b> . Grassland in tropic climates	Perennial (bushes, cacti, Euphorbi(a)). Plants have shallow root system, waterproof waxy coating to prevent loss, water conservation.	Perennial flowers, dwarf willows, lichen (reindeer moss). Treeless tundra of high latitude is called <b>arctic tundra</b> . Tundra of high altitude is





## Chapter 26

## Some Major Ecosystem

	<p>herbs make <b>field layer</b>.</p> <ul style="list-style-type: none"> <li>Mosses, liverworts, lichen form <b>floor layer</b>.</li> </ul>	<p>are called <b>alpine</b>. Coniferous forests of high latitude are called <b>boreal</b>.</p>	<p>with woody trees is called <b>savanna</b>. Tall grasses (Andropogon, Panicum) form the <b>first layer</b>. Mid high grasses (Stipa, Sporobolus, Oryzopsis) form the <b>second layer</b>. Short grasses, forbs &amp; warfare species (Poa, Bromus), mosses, lichen form <b>third layer</b>.</p>		<p>called <b>alpine tundra</b>.</p>
<b>Animals</b>	<p>Macaca mulatto (Rhesus monkey), Solenorotos tibitanus (black bear), Felis bengalensis (leopard cat), deer &amp; wolves, bacteria, fungi &amp; earthworm.</p>	<p>Bison, wolf, black bear, deer, Marcopolo sheep, Kashmiri flying squirrel, snowshoe hare, wolverine, crossbill.</p>	<p>Herbivore invertebrates e.g. insects, grasshopper. Predators e.g. reptiles, amphibians, mammals, lizards, toads, turtles, foxes, wolves preying insects. Decomposers e.g. bacteria, actinomycetes, fungi like molds, yeasts, mushrooms, bracket fungi. Large animals e.g. zebras, horses, bison.</p>	<p>Nocturnal e.g. horned lizards, snakes, kangaroos, rats, burrowing owl. Animals storing water e.g. desert bighorn sheep &amp; camel.</p>	<p>Mosquitoes &amp; other insects in standing water pools. Ducks &amp; geese. Wolves, snowy owls, arctic foxes &amp; grizzly bears.</p>
<b>Human impact</b>	<p>Black bear, deer, wolves, bobcats &amp;</p>	<p>Somewhat undisturbed due to</p>	<p>Used for crop production &amp; live stock</p>	<p>Less</p>	<p>Used for oil drilling sites.</p>





## Chapter 26

## Some Major Ecosystem

	mountain lions wiped out by man. Forests reduced due to need of lumber and agriculture land.	severity of climate & remoteness. Forests major source of lumber for construction.	management. Not for cultivation due to acidity & salinity. Converted to deserts called desertification.		pipelines & military bases only.
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1. \_\_\_\_\_ refers to overall patterns of weather that prevail from year to year even century to century in a particular region.
2. Salt-water ecosystem covers about \_\_\_\_\_ earth surface.
3. Near shore zone of lake water ecosystem is \_\_\_\_\_.
4. Northern coniferous forests are also called \_\_\_\_\_.
5. Grasslands present in temperate climates are called \_\_\_\_\_.
6. Treeless tundra of high latitude between taiga and polar ice caps is called \_\_\_\_\_.

Answers: (1) Climate (2) 71% (3) Littoral Zone (4) Taiga (5) Prairies (6) Arctic Tundra



VALUES

Property	Value
Salt water ocean and sea ecosystem of earth surface	71%
Fresh water ecosystem covering earth surface	Less than 1%
Average rain fall in temperate deciduous forests	750-1500 mm
Temperature range in temperate deciduous forests	4°C-30°C
Maximum height of herbs & shrubs in temperate deciduous forests	5m
Temperature range in coniferous forests	Below F.P to 10°C
Annual rainfall in grassland	250-750 mm (10-30 inches)
Annual rainfall in tropical and subtropical grassland	1500 mm (60 inches)
Rate of primary production in temperate grassland	700-1500 g/m <sup>2</sup>
Rate of primary production in subhumid tropical grassland	4000 g/m <sup>2</sup>
Amount of herbage consumed by grazing animals in annual grassland	5-10%
Location of desert biomes	20 to 30 north & south latitude
Annual rainfall in desert ecosystem	25-50 cm (10-20 inches)
Length of willow (50 years old)	10 cm (4 inches)
Width of willow (50 years old)	7 cm (3 inches)





## PRACTICE EXERCISE



1. **Weather refers to**
  - (a) Short-term fluctuations in temperature, cloud cover, wind and precipitation
  - (b) It prevails over periods of hrs or days
  - (c) Overall patterns of weather that prevail from year to year
  - (d) Both a and b
2. **Which statement about hydrospheric ecosystem is incorrect?**
  - (a) Salt water ocean and sea are the largest ecosystems on earth
  - (b) Salt water ecosystem covers about 75% earth surface
  - (c) Fresh water ecosystem covers less than 1% of earth surface
  - (d) Its temperature is more moderate to support life
3. **Productivity of an ecosystem is indicated by**
  - (a) Number of plants in that ecosystem
  - (b) The density of that ecosystem
  - (c) Consumption of carbon dioxide and evolve of oxygen
  - (d) Both a and b
4. **In which zone plant community is most diverse**
  - (a) Limnetic zone
  - (b) Littoral zone
  - (c) Profundal zone
  - (d) All of these
5. **Which statement about profundal zone is correct?**
  - (a) Plants are unable to anchor but enough light penetrates to support photosynthesis
  - (b) Phytoplanktons in this region are cyanobacteria
  - (c) Decomposers and detritus feeders inhabit it
  - (d) Water lilies are abundant
6. **Eutrophication is**
  - (a) Process of decreasing nutrients by human activities
  - (b) Adequate nutrition accelerated by human activities
  - (c) Changing the trophic levels of an ecosystem by human activities
  - (d) Addition of more predators in an ecosystem
7. **In polluted lake which organisms dominate the community**
  - (a) Fish
  - (b) Crustaceans
  - (c) Phytoplanktons
  - (d) Blue green algae
8. **Evolution of vascular bundles in plants and skeleton in animals is an adaptation for**
  - (a) Hydrospheric ecosystem
  - (b) Aquatic ecosystem
  - (c) Terrestrial ecosystem
  - (d) All of these
9. **Development of bark in plants and skin in animals is a method for**
  - (a) Providing support
  - (b) Protection from enemies
  - (c) Reducing water loss
  - (d) Helping in food production
10. **Which statement is incorrect?**
  - (a) Average rainfall in temperate deciduous forests is 750-1500mm
  - (b) Temperature of coniferous alpine and boreal forests is upto 10 degrees
  - (c) Northern coniferous forests are called Taiga
  - (d) Coniferous forests located at high latitude are alpine

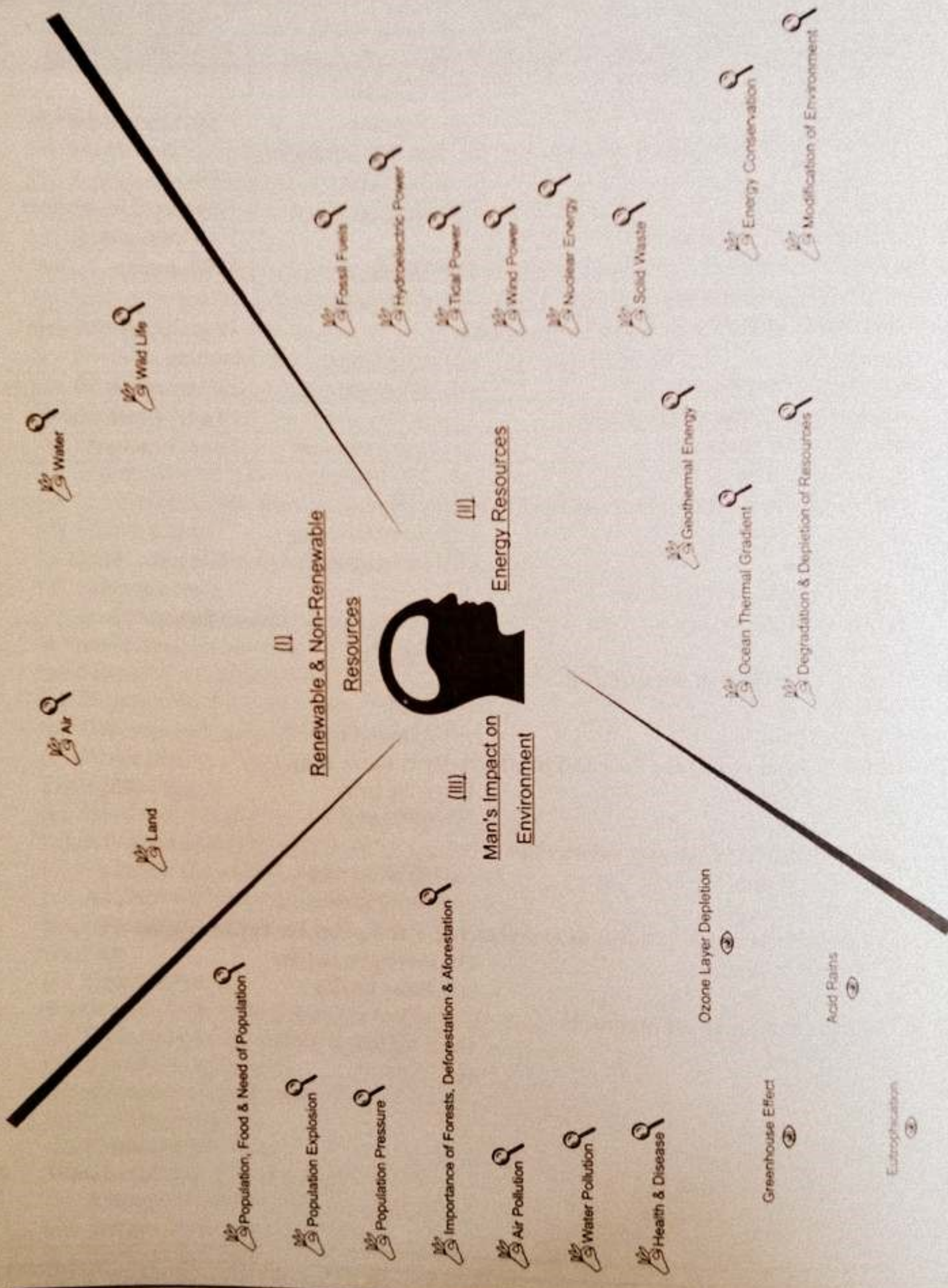


11. Temperature of temperate deciduous forests is
  - (a) 4-30 degree C
  - (b) 45-50 degree C
  - (c) 20-25 degree C
  - (d) 5-10 degree C
12. Coniferous forests located at high altitude are called
  - (a) Taiga
  - (b) Alpine
  - (c) Boreal
  - (d) Arctic
13. Grass land in tropic climates with woody trees is called
  - (a) Prairies
  - (b) Savanna
  - (c) Boreal
  - (d) Alpines
14. Zone of lake water which is of open water near the surface is
  - (a) Littoral
  - (b) Limnetic
  - (c) Profundal
  - (d) Benthic
15. Ecosystem of Shogran is
  - (a) Coniferous alpine
  - (b) Boreal
  - (c) Temperate deciduous
  - (d) Grassland
16. Mountains of Koh Hindukush come under
  - (a) Tundra
  - (b) Grass land
  - (c) Tropical forests
  - (d) Temperate deciduous
17. Annual rainfall in grass land is
  - (a) 1500-2500 mm
  - (b) 750-1500 mm
  - (c) 250-750 mm
  - (d) 250-500 mm
18. One of the most important cause of desertification is
  - (a) Floods
  - (b) Wind blowing
  - (c) Raining
  - (d) Deforestation
19. 'End of earth' is related to
  - (a) Tropical rain forest
  - (b) Temperate deciduous forest
  - (c) Savanna
  - (d) Tundra
20. Desert ecosystem of Mianwali is
  - (a) Thar
  - (b) Thal
  - (c) Cholistan
  - (d) None of these
21. In sub-humid tropical grassland productivity is more than
  - (a)  $700-1500\text{g/m}^2$
  - (b)  $4000\text{g/m}^2$
  - (c)  $5000\text{g/m}^2$
  - (d)  $6050\text{g/m}^2$
22. Annual rainfall in deserts is less than
  - (a) 150-200 mm
  - (b) 500-700 mm
  - (c) 250-500 mm
  - (d) 700-800mm
23. Treeless tundra of high latitude between taiga and polar ice caps is called
  - (a) Northern tundra
  - (b) Antarctic tundra
  - (c) Arctic tundra
  - (d) Polar tundra
24. The most fragile of all biomes is
  - (a) Grassland
  - (b) Coniferous alpine
  - (c) Desert
  - (d) Tundra



# Chapter 27

## MAN & HIS ENVIRONMENT

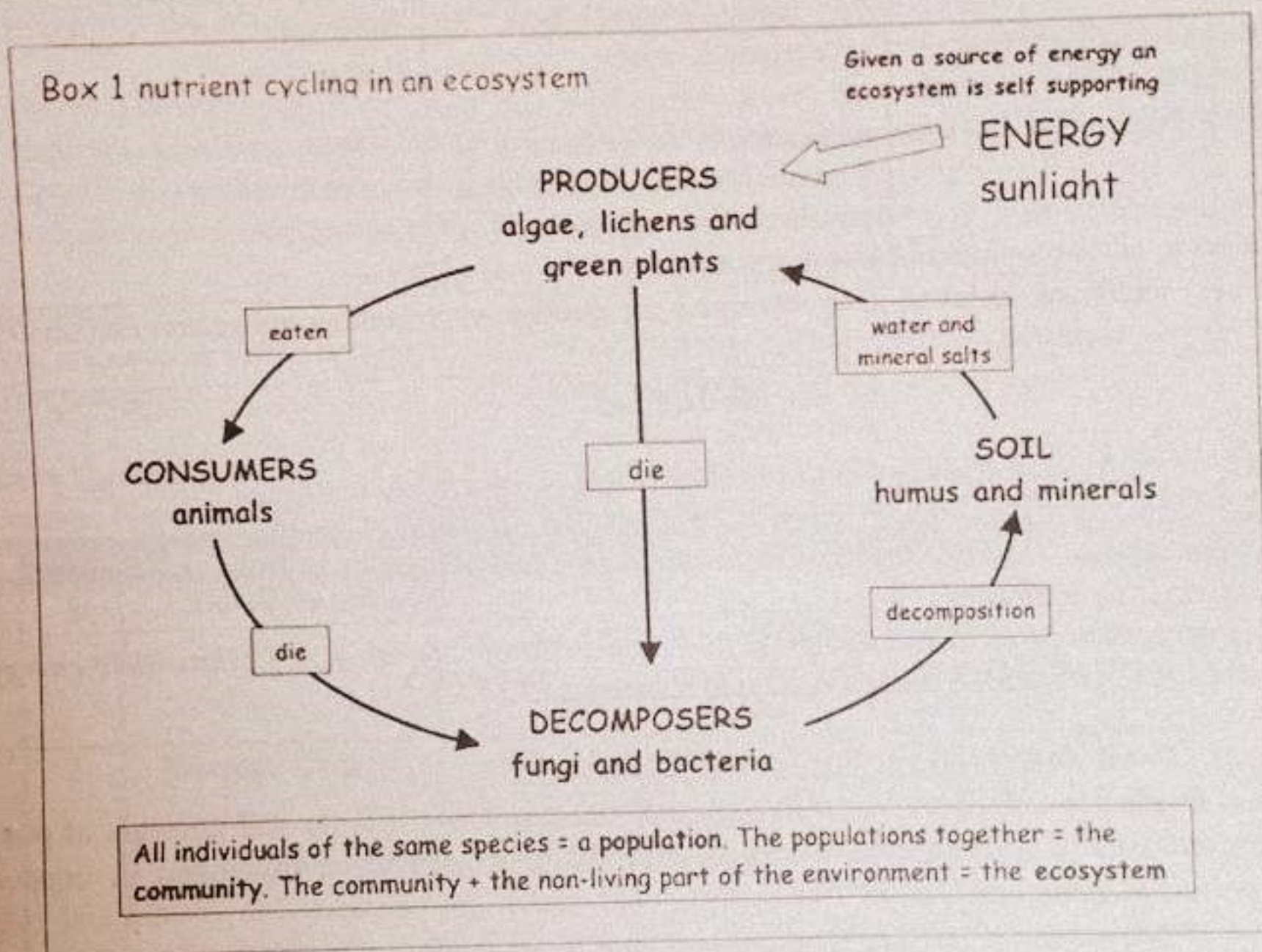




*Environment* is treasure of all types of resources essential to maintain life on earth.

### RENEWABLE AND NON-RENEWABLE RESOURCES

- *Environmental resources* are divided into two types i.e. renewable and non-renewable.
- Environmental resources, which cannot be depleted are called *renewable resources* e.g. air, water, food, land, forests and wild life.
- Such resources, which are exhaustible and once consumed cannot be replaced are called *non-renewable resources* e.g. various metals, non-metallic minerals and fossil fuels (coal, oil and natural gas).
- Process that supplies food to living things through decaying and decomposition is called *nutrient cycle*.
- *Natural Cycles* have no beginning and no end.
- Driving force behind all these cycles is the sun.
- Earth is a self-sustained unit



- The *balance in the nutrient cycle* can be upset when
  - Not enough food is produced
  - Too much food is consumed
  - Decayed nutrients are not returned to the ground





### RENEWABLE RESOURCES

#### Air

- It is several kilometer thick blanket of atmosphere surrounding the earth.
- Air consists of nitrogen (79%), oxygen (20%), carbon dioxide (0.03%) and traces of inert gases called noble gases.
- Carbon dioxide and nitrogen are used as raw materials in food manufacture.
- Green house effect and acid rains are global effects of the pollution.

#### Water

- It is also component of soil and air
- 75% of earth surface is covered with water.
- Water is major constituent of *living organisms* comprising 70-90% of total body weight.
- About 97% of total water of planet earth is in *oceans*, 2% in form of *frozen ice caps* and only 1% as *fresh water* in lakes, streams and rivers.

#### Use of water

*Domestic or irrigation* use of water is about 90% while 10% water is used in *industries*.

#### Land

- *Soil* can be defined as upper layer of earth crust.
- Only 30% of earth is *land*.
- 11% of the total area of the world is *under cultivation*.

#### Wild life

- It refers to all non-cultivated plants and non-domesticated animals.
- Species, which are reduced in number and are at edge of extinction are called *endangered species*.

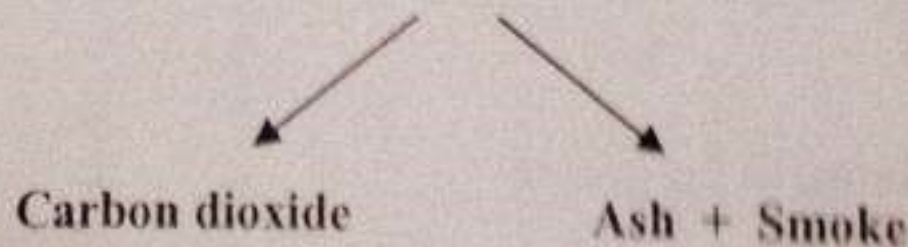
### ENERGY

- Energy resources are classified into exhaustible and inexhaustible resources.
- Such energy resources, which cannot be depleted, are called *inexhaustible energy resources* e.g. solar energy, falling water (hydropower), wind, ocean thermal gradient, tides, currents, geothermal and biomass.
- Such energy resources, which are going to be depleted with use are called *exhaustible energy resources* e.g. fossil fuels like coal, oil and natural gas.

#### Fossil fuels

- *Fossil Fuels* are called so because they are the remains of plants and animals of past which became buried due to environmental hazards and were fossilized in deeper layers of earth and sea.
- 95% of our daily energy requirements are met from fossil fuels.

Dead plants → Peat → Lignite → Coal





**Hydroelectric power**

- *Rain* is a renewable energy source, which gets its energy indirectly from sun.
- Electricity produced from falling water is called *hydroelectric power*. It is cheapest and non-pollutant form of energy.

**Tidal power**

- *Tides* are caused by gravitational pull of moon to a lesser extent and gravitational pull of sun on water in sea and oceans.
- A tidal power station consists of a long barrier called a *tidal barrage*.

**Wind power**

- *Wind* is moving air.
- Wind blows from area of high pressure to area of lower pressure

**Nuclear energy**

It is obtained from nuclear fuels by *nuclear fission* in a nuclear reactor

**Geothermal energy**

- Natural heat energy trapped underground is called *geothermal energy*.
- *Geothermal power plants* are working at New Zealand and Ice Land.
- Volcanoes, hot springs and geysers allow the escape of hot substance from inside of the earth

**Solid wastes**

These are used to produce oil and gas through hydrogenation, pyrolysis (destructive distillation) or bioconversion.

**Ocean thermal gradient**

In oceans of tropical regions, temperature of surface water is about 25°C and 5°C at depth.

	Energy Source	Advantages	Disadvantages
1	<b>Fossil Fuels</b>	Supply 95% of energy. Transport systems, electricity, industry	Pollution. Mining and drilling destroys forests and wild life.
2	<b>Nuclear Energy</b>	Electricity generation	Upsets ecosystem Disposal of wastes Exposure to radiation can cause death (Chernobyl's) 1986 Cancer of lungs,, bone marrow, skin.
3	<b>Hydro-Electric power</b>	Supply of water will never run out Hydroelectric power is clean, pollution free and less expensive.	Natural ecosystems are destroyed to develop dams Life of dams is limited and power generation capacity is lost due to silting.





4	Solar Energy	Can be used in residential areas for heating of water, houses, schools etc. Economical as compared to electricity Solar air conditioning Solar cells generate electricity.	Technical problems concerning economics and distribution of solar energy. Solar cells are too expensive.
5	Geothermal Energy	Electricity generation Less expensive than ordinary power plants using fossil fuels.	Low amount of energy is produced Air and heat pollution Salty waste water 1- Environmental hazard 2-Corrodes equipment.
6	Wind Energy	Electricity generation	Uncertainty of weather Visual pollution High cost
7	Solid Wastes	Hot gases used to generate electricity By burning 400 tons of municipal refuse 15,000 kwatt electric power can be produced Bioconversion (methane produced by digestion of organic wastes)	Sulphur emission Release of polluted water Disposal of organic sludge.
8	Ocean thermal Gradient	Drive turbine for electricity generation	Temperature changes Marine life is disturbed
9	Tidal power	Large-scale electricity generation A dammed bay can function as regular hydro-electric power plant.	Tidal waves cannot be directly used. Only few coastal areas are feasible Cost of power transmission will be high

### HUMAN IMPACT ON ENVIRONMENT

#### Population, Food and Need Of Population Control

##### Population Explosion

- **Demography** is the study of human populations and things that affect them.
- **Population of Pakistan** was 32.5 million in 1947, it has now increased to around 150-160 million in year 2000.
- About 20 years ago, human population was increasing at rate of 2% and was doubling every 35 years.





S.No.	Reasons for world Population explosion	Consequences of population increase
1	Disease prevention medicine, public, personal and food hygiene	Overcrowding, less living space, more people; more crime, violence and social diseases
2	Improved nutrition by efficient agriculture	Starvation through lack of sufficient food
3	Housing and living standards improved	Populations will outstrip food supply
4	Child care, maternity, parent-craft and welfare services	Destruction of the countryside, plants, animals and wildlife

### DEFORESTATION AND AFFORESTATION

- Clearance of vast areas of forest for lumber, planting subsistence crops or grazing cattle is called **deforestation**.
- The destruction of forests leaves the soil barren and it is called deforestation leading to **desertification**.
- **Reforestation** is replantation of plants in the areas where they were present earlier.
- In reforestation coniferous species are important which often require bare soil to establish.
- **Aforestation** is establishment of new forests where no forests existed previously.
- Forests are called as **environmental buffers** because they break speed of wind, rain and floods.
- About half of the rain, which falls, in tropical forests comes from transpiration of these plants
- **Biodiversity** is total number of different species within an ecosystem and the resulting complexity of interactions among them

### POLLUTION

- Any thing produced by human which is or may be harmful to human life and other living organisms is called **environmental pollution**.
- Harmful substance, which cause pollution are called **pollutants**.

#### **Types Of Pollution**

- Air or atmospheric pollution
- Water pollution
- Soil pollution
- Radiation pollution
- Noise pollution

#### **Air Pollution**

- "The befouling of the air by anything that may be harmful to living organisms is air pollution"



OZONE LAYER DEPLETION

- Ozone is layer of atmosphere extending from 10-50 km above earth, which filters and protects us from UV rays.
- In pure form ozone is bluish, explosive and highly poisonous gas. Ozone molecule is made up of 3 oxygen atoms  $O_3$ .
- Decline in thickness of ozone layer is called *ozone depletion*.
- Ozone depletion is caused by *chlorofluorocarbon (CFCs)*, which contains chlorine, fluorine and carbon. These are produced from air conditioners and refrigerators.
- A single chlorine atom can react with ultraviolet rays and destroys as many as one million ozone molecules.
- The level of ozone in the ozone layer over the *Antarctica* has fallen drastically and has led to a hole.
- UV rays cause skin cancers and cataracts in human.

GREEN HOUSE EFFECT

- *Green house gases* are those, which prevent heat to escape out from them e.g.  $CO_2$ .

Sun rays penetrate green house → absorbed by plants and soil → reradiate as longer wave infra-red radiations(heat) → these rays cant escape out from the glass → so heat remains within the green house

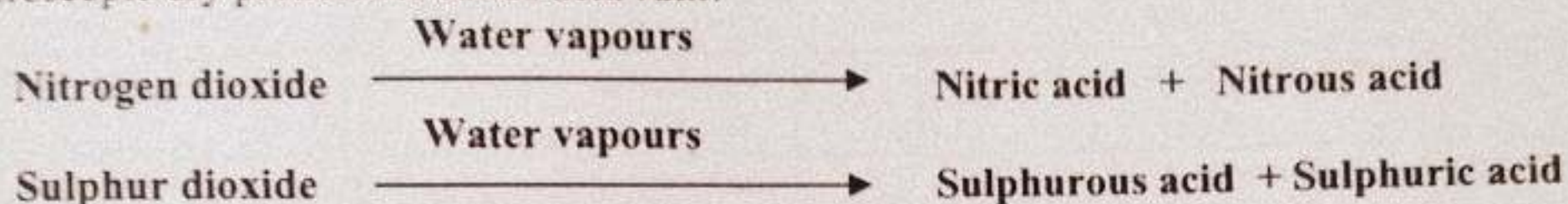
- Increase in earth's atmosphere due to  $CO_2$  and retention of heat rays is called *green house effect*.
- Causes of green house effect are:
  - Over urbanization
  - Deforestation
  - industrialization
- Heating of earth is called *global warming*.

AIR POLLUTANT	SOURCES	HARMFUL EFFECTS
Chlorofluorocarbons	Aerosal spray foams, air conditioning system, refrigerants	Thinning of ozone layer, green house effect, global warming
Sulphur dioxide	Power station, fossil fuel	Acid rains, breathing disorders, lung cancer
Lead compounds	Combustion of leaded petrol or oils	Lead poisoning, brain damage, forest decline
Oxides of nitrogen	Burning of fossil fuels	Global warming, green house effect, acid rain, headache, cough
Carbon monoxide	Incomplete burning of carbonate & carbon compounds, cigarette smoke	Headache, brain damage, death



### ACID RAIN

Acid (of sulphur dioxide or nitrogen dioxide) falls on earth either dissolved in rain or as microscopic dry particles is called *acid rain*.



### EUTROPHICATION or ALGAL BOOM

- This is the natural process of excessive enrichment of water with nutrients by which large amount of living organic matter grows in the water
- Large amount of phosphates from detergents encourages growth of microscopic plants called *eutrophication*.
- Eutrophication is also called *algal bloom*.
- It is called **algal bloom** because vast quantities of algae feed and reproduce on these nutrients causing water to turn green with algal bloom.
- The chemical wastes from industry are called *effluents*.

### INSECTICIDES, HERBICIDES AND FERTILIZERS

- *Agrochemicals* are commonly called pesticides and fertilizers
- *Monoculture* is population of only one species e.g. wheat. Monocultures are more susceptible to attack of pests.

Pesticides	→	Kills pests
Insecticide	→	Kills insects
Fungicide	→	Kills parasitic fungi
Herbicide	→	Kills 'weed' plants

- *Fertilizers* are the chemical substances used to add additional nutrients to the soil to increase its fertility

### HEALTH AND DISEASES

- The steady internal state of homeostasis is known as *normal health*.
- *Disease* refers to departure from normal on steady internal state of homeostasis through structural or functional disorders of the body.



Classification and Causes of Diseases

CAUSES OF DISEASE	NAME OF DISEASE
Genetic/ heritable/ congenital	Hemophilia, Down's syndrome, Turner's syndrome
Infectious/ pathogenic/ parasitic	Diphtheria, Malaria, Small pox, Tuberculosis, Cholera, Gonorrhea, AIDS
Nutritional deficiency	Scurvy, Beriberi, Anemia, Goiter, Kwashiorkor
Metabolic/ Hormonal	Diabetes mellitus, Cretinism, Goiter
Physical disorders (injury, accident, heat, cold, radiation)	Fracture, burn
Chemical	Drug abuse, Smoking, Alcoholism, Food poisoning
Aging/ Degenerative	Osteoarthritis, Arteriosclerosis
Mental illness	Alzheimer



1. Driving force behind all nutrient cycles is the \_\_\_\_\_.
2. \_\_\_\_\_ is several kilometer thick blanket of atmosphere surrounding the earth.
3. \_\_\_\_\_ refers to all non-cultivated plants and non-domesticated animals.
4. Electricity produced from falling water is called \_\_\_\_\_.
5. \_\_\_\_\_ is the study of human populations and things that affect them.
6. \_\_\_\_\_ is establishment of new forests where no forests existed previously.
7. \_\_\_\_\_ rays cause skin cancers and cataracts in human.

Answers: (1) Sun (2) Air (3) Wild Life (4) Hydroelectric Power (5) Demography (6) Afforestation (7) UV





## VALUES

Property	Value
Adoption of agriculture	About 10,000 years ago
Percentage of nitrogen in air	79%
Percentage of oxygen in air	20%
Percentage of CO <sub>2</sub> in air	0.03%
Water covering earth surface	75%
Percentage of water in living organisms	70-90%
Percentage of water in oceans	97%
Percentage of water in form of frozen ice-caps	2%
Percentage of fresh water	1%
Domestic & irrigation use of water	10%
Industrial use of water	90%
Percentage of earth as land	30%
Total area of world under cultivation	11%
Fulfillment of our energy requirements from fossil fuels	95%
Temperature of surface water of ocean in tropical regions	25°C
Temperature of depth of ocean in tropical regions	5°C
Age of modern man	40,000 years
Commencement of human culture	5000 years ago
Population of Pakistan in 1947	32.5 million
Population of Pakistan in year 2000	150-160 million
Rate of increase in human population 20 years ago	2%
Distance of ozone layer from earth surface	10-50 kilometers





## PRACTICE EXERCISE

 35 mins  
Time Yourself

1. Which one is a non-renewable resource?  
 (a) Wild life (b) Forests  
 (c) Natural gas (d) Land
2. Process that supplies food to living things through decaying and decomposition is called  
 (a) Food cycle (b) Nutrient cycle  
 (c) Dead-live cycle (d) None of these
3. Balance in the nutrient cycle can be upset when  
 (a) Too much food is consumed  
 (b) Not enough food is produced  
 (c) Decayed nutrients are not returned to the ground  
 (d) All of these
4. In air nitrogen is  
 (a) 57% (b) 20%  
 (c) 79% (d) 30%
5. In air % of oxygen and carbon dioxide is  
 (a) Oxygen 20%, CO<sub>2</sub> 0.03% (b) Oxygen 50%, CO<sub>2</sub> 50%  
 (c) Oxygen 30%, CO<sub>2</sub> 0.05% (d) Oxygen 25%, CO<sub>2</sub> 0.02%
6. Water constitutes --% of body weight?  
 (a) 25-30% (b) 70-90%  
 (c) 10-30% (d) 30-50%
7. Which statement is true?  
 (a) 20% of total water is in the form of frozen ice caps  
 (b) 80% is in oceans  
 (c) 1% as fresh water lakes, streams and rivers  
 (d) 10% is in canals
8. Total area of the world under cultivation is  
 (a) 5% (b) 11%  
 (c) 21% (d) 31%
9. Wild life refers to  
 (a) All plants of the world (b) All non cultivated plants  
 (c) Non domesticated animals (d) Both b and c
10. Endangered species are  
 (a) Dangerous for the life of humans (b) Reduced in number  
 (c) Already extinct (d) All of these
11. \_\_\_\_\_% of our energy requirements are met from fossil fuels  
 (a) 50 (b) 55  
 (c) 90 (d) 95
12. Which sequence is correct?  
 (a) Dead plants → lignite → peat → coal (b) Dead plants → peat → lignite → coal  
 (c) Dead plants → coal → lignite → ash (d) Dead animals → peat → lignite → coal
13. Hydroelectricity is generated by using \_\_\_\_\_ of falling water.  
 (a) Potential energy (b) Gravitational energy  
 (c) Kinetic energy (d) All of these





14. **Driving force for all the cycles in ecosystem is**
  - (a) Water
  - (b) Soil
  - (c) Sun
  - (d) Air
15. **Tides are caused by**
  - (a) Gravitational pull of sun
  - (b) Movements of large animals in water
  - (c) Uneven water body floor
  - (d) High winds
16. **Wind blows from area of**
  - (a) Low pressure to high pressure
  - (b) High pressure to low pressure
  - (c) Moderate pressure to high pressure
  - (d) Low pressure to low pressure
17. **Geothermal energy is**
  - (a) Energy obtained from nuclear fuel
  - (b) Energy obtained from burning natural fuels
  - (c) Heat energy trapped underground
  - (d) Energy obtained from blowing hot winds
18. **Hot substance is escaped from inside the earth in the form of**
  - (a) Volcanoes
  - (b) Hot springs
  - (c) Geysers
  - (d) All of these
19. **In oceans of tropical regions**
  - (a) Temperature of surface water is 40°C and 10°C at depth
  - (b) Temp of surface water is 25°C and 5°C at depth
  - (c) Surface water 50°C and depth 20°C
  - (d) Surface water 10°C and depth 15°C
20. **Study of human population and things that affect them is**
  - (a) Ecology
  - (b) Demography
  - (c) Demology
  - (d) Environment study
21. **In 1947 population of Pakistan was**
  - (a) 32.5 million
  - (b) 35.5 million
  - (c) 40.5 million
  - (d) 45.5 million
22. **Rate of population growth in 1980s was**
  - (a) 10%
  - (b) 1%
  - (c) 2%
  - (d) 15%
23. **Replantation of plants in the areas where they were present earlier is called**
  - (a) Deforestation
  - (b) Aforestation
  - (c) Forestation
  - (d) Reforestation
24. **Establishment of new forests where no forests existed previously is called**
  - (a) Reforestation
  - (b) Forestation
  - (c) Neoforestation
  - (d) Aforestation
25. **Which is environmental buffer?**
  - (a) Mountains
  - (b) Deserts
  - (c) Forests
  - (d) Oceans
26. **About half of the rain which falls in tropical forests comes from**
  - (a) High winds
  - (b) Cold surroundings
  - (c) Transpiration of plants
  - (d) Surrounding seas
27. **Biodiversity is**
  - (a) Total number of species in a community
  - (b) Total number of species in an ecosystem
  - (c) Total number of genus in an ecosystem
  - (d) None of these
28. **Which statement is not true about ozone?**
  - (a) Bluish
  - (b) Explosive
  - (c) 10-50 km
  - (d) O<sub>2</sub>





29. Ozone depletion is commonly caused by
  - (a) CFCs
  - (b) Industrial smoke
  - (c) Heavy nitrogen gasses
  - (d) Carbon dioxide
30. Diseases caused by UV rays in humans
  - (a) Skin cancers
  - (b) Cataracts
  - (c) Night blindness
  - (d) Both a and b
31. Which gas commonly causes green house effect?
  - (a) Hydrogen sulphide
  - (b) Carbon dioxide
  - (c) Nitrogen gas
  - (d) Carbon monoxide
32. Causes of green house effect are
  - (a) Over urbanization
  - (b) Deforestation
  - (c) Industrialization
  - (d) All of these
33. Sun rays are reradiated from the earth's surface in the form of
  - (a) Long wave radiations
  - (b) Short wave radiations
  - (c) Radiowaves
  - (d) Medium waves
34. Incomplete burning of carbon compounds cause release of
  - (a) Carbon dioxide
  - (b) Carbon monoxide
  - (c) Oxides of nitrogen
  - (d) CFCs
35. Acid rain is caused by
  - (a) Sulphur dioxide
  - (b) Oxides of nitrogen
  - (c) Both a and b
  - (d) None of these
36. Algal bloom is also called as
  - (a) Deforestation
  - (b) Eutrophication
  - (c) Neotrophication
  - (d) Lichen
37. The chemical wastes from industry is called
  - (a) Industrial litter
  - (b) Industrial trash
  - (c) Industrial effluents
  - (d) Industrial deffluents
38. Pesticides and fertilizers are also called
  - (a) Pestochemicals
  - (b) Industrochemicals
  - (c) Killing chemicals
  - (d) Agrochemicals
39. Which are more susceptible to attacks of pests?
  - (a) Multicultures
  - (b) Monocultures
  - (c) Dicultures
  - (d) Polycultures
40. Which disease does not match its etiology?
  - (a) Kwashiorkor is a nutritional deficiency
  - (b) Alzheimer is a mental illness
  - (c) Cretinism is due to hormonal imbalance
  - (d) Cholera is physical disorder
41. Detergents usually release
  - (a) Carbonates
  - (b) Sulphates
  - (c) Phosphates
  - (d) Nitrates
42. Diphtheria is
  - (a) Genetic disease
  - (b) Pathogenic disease
  - (c) Metabolic disease
  - (d) Nutritional disease
43. Which one of the following is not nutritional disease?
  - (a) Scurvy
  - (b) Anemia
  - (c) Goiter
  - (d) Diabetes



# SCIENTISTS

YEAR	SCIENTIST	ACHIEVEMENT
1955	Bradford	Mechanism of action of cilia
1907	Alois Alzheimer	Alzheimer's disease
1859	Darwin	Definition of instinct as animal behaviour
1935	Uexkull, Lorenz	Early ethologist, sign stimuli
	Thorpe	Definition of learning Latent learning
	Pavlov	Conditioned reflex type I
	Tharndike, B.F. Skinner	Conditioned reflex type II
	Kohler	Insight learning in chimpanzee
1954	H. Huxley & A.F. Huxley	Sliding filament model of muscle contraction
1920	Garner & Allard	Effect of photoperiodism
1934	Thimann & skoog	Effect of auxins on apical dominance
1892	Hans Dietrich	Mechanism of development in sea urchin
	Spemann	Mechanism of development in salamander zygote.
1924	Spemann & Halide Mangold	Embryonic induction in salamander embryo
	Haemmerling	Role of nucleus in development of Acetabularia
1900	Karl Correns	<ul style="list-style-type: none"> <li>Central role of chromosome in heredity</li> <li>Rediscovery of Mendelian work</li> <li>Incomplete dominance in 4 O'clock plant</li> </ul>
1902	Walter Sutton	Formulated chromosomal theory of inheritance
1910	Thomas Hunt Morgan	<ul style="list-style-type: none"> <li>Discovery of sex chromosome</li> <li>Sex linkage in Drosophila</li> <li>Confirmation of chromosomal theory of inheritance</li> </ul>
	Frederick Griffith	First evidence of DNA as heredity material
1944	Oswald Avery, Colin Macleod & Maclyn McCarty	<ul style="list-style-type: none"> <li>DNA as transforming principle</li> <li>Experimental proof about DNA as heredity material</li> </ul>
1952	Alfred Hershey & Martha Chase	Conclusive evidence about DNA as heredity material by using radioactive isotopes
1869	Friedrich Miescher	Discovery of DNA
1920	P.A. Levene	Basic structure of DNA
	Erwin Chargaff	Ratio between nitrogenous bases in DNA
	Rosalind Franklin & Maurice Wilkins	X-ray diffraction model of DNA
1953	James Watson &	<ul style="list-style-type: none"> <li>Double helical structure of DNA</li> </ul>



	Francis Crick	* Semiconservative model of DNA
1958	Mathew Meselson & Franklin Stahl	Evaluation & confirmation of semiconservative method of DNA replication
1902	Archibald Garrod & William Bateson	* Hereditary diseases as Mendelian traits * Alkaptonuria
1941	George Beadle & Edward Tatum	* Definitive evidence about hereditability of gene in inheritance * One gene one enzyme hypothesis * Work on neurospora
1953	Frederick Sanger	Sequence of amino acids in insulin
1956	Vernon Ingram	Molecular basis of sickle cell anaemia
	Marshall Nirenberg, Philip Leder & Hai Gobind Khorana	Testing 64 codons by making artificial mRNA
1822-1884	Gregor Johann Mendel	Founder of classical genetics
	Johannsen	Renamed Mendelian factors as 'genes'
1900	Correns, De Vries & Tschermach	Rediscovered Mendel's work
1901	Landsteiner	MN, ABO & Rh blood group system
	Levine	MN Blood group system
1925	Berstein	Genetic basis of ABO system
	Nilsson-Ehle	Genetics of wheat grain colour
	Calvin Bridges	Observed white eye mutant male <i>Drosophila</i>
1970	Hamilton O Smith	Isolated 1 <sup>st</sup> restriction enzyme
1983	Kary B. Mullis	Polymerase chain reaction
	J. Craig Venter	Founder of company for gene sequencing
1902	Gottlieb Haberlandt	Plant cells are totipotent
1958	F.C. Steward	Grew a complete carrot plant from a tiny piece of phloem
1987	John C Sanford & Theodore M. Klein	Particle gun method
	Linnaeus	Binomial nomenclature, Special creation
1809	Lamarck	Inheritance of acquired characters
	Malthus	Essay on Principle of population
	Cuvier	Palaeontology, Theory of catastrophism
	Lyell	Principles of geology
1858	Darwin	Origin of species by natural selection
	Wallace	Support to Darwin's theory
	Lynn Margulis	Endosymbiont hypothesis
1908	Hardy & Weinberg	Frequencies of genotypes of non-evolving population
1866	Ernst Haeckel	Ecology as study of relationship of animals to their environment
1917	Joseph Grinnell	First to propose term niche in ecology
	Charles Eton	Niche as basic role of organism in community





## SCIENTIFIC NAMES

COMMON NAME	SCIENTIFIC NAME
Fruitfly	<i>Drosophila melanogaster</i>
Corn	<i>Zea mays</i>
Onion	<i>Allium cepa</i>
Amaltas	<i>Cassia fistula</i>
Man	<i>Homo sapiens</i>
Potato	<i>Solanum tuberosum</i>
Brinjal/ Egg plant	<i>Solanum melangena</i>
Tomato	<i>Lycopersicum esculentum</i>
Brown surgeonfish	<i>Acanthurus nigrofusus</i>
Giant amoeba	<i>Pelomyxa palustris</i>
Typical amoeba	<i>Amoeba proteus</i>
Slime mold	<i>Physarum polycephalum</i>
Water mold	<i>Phytophthora infestans</i>
Oyster mushroom	<i>Pleurotus ostreatus</i>
Black bread mold	<i>Rhizopus</i>
Wheat smut	<i>Ustilago tritica</i>
Corn smut	<i>Ustilago maydis</i>
Rust fungi	<i>Puccinia</i>
Blue, green mold	<i>Penicillium</i>
Brown mold	<i>Aspergillus</i>
Mushrooms	<i>Agaricus</i>
Morels	<i>Morchella esculenta</i>
Death cap/ death angel	<i>Amanita</i>
Jack-O' lantern	<i>Omphalotus olearius</i>
Yeast	<i>Saccharomyces cerevisiae</i>
Penicillium	<i>Penicillium notatum</i>
Pink bread mold	<i>Neurospora</i>
Yeast	<i>Candida albicans</i>
Aspergillus	<i>Aspergillus fumigatus</i>
Pink yeast	<i>Rhodotorula</i>
Hair Cup Moss Plant	<i>Polytrichum</i>
Maiden Hair Fern	<i>Adiantum</i>
Sago Palm	<i>Cycas</i>
Pine	<i>Pinus</i>
Yew	<i>Taxus</i>
Hemlock	<i>Picea</i>
Deodar	<i>Cedrus</i>
Pear	<i>Pyrus</i>
Rose	<i>Rosa</i>
Apple	<i>Malus</i>
Strawberry	<i>Fragaria</i>
Potato	<i>Solanum tuberosum</i>



Tobacco	<i>Nicotiana tobacum</i>
Tomato	<i>Lycopersicum esculentum</i>
Red Pepper	<i>Capsicum frutescens</i>
Egg Plant (Brinjal)	<i>Solanum molangena</i>
Ground Cherry	<i>Physalis</i>
Sweet Pea	<i>Lathyrus odoratus</i>
Peanut	<i>Arachis hypogea</i>
Chick Pea	<i>Cicer arietinum</i>
Shisham	<i>Dalbergia sissoo</i>
Alfafa	<i>Medicago sativa</i>
Imli	<i>Tamarindus indica</i>
Kachnar	<i>Bauhinia variegata</i>
Amaltas	<i>Cassia fistula</i>
Touch me not	<i>Mimosa pudica</i>
Wheat	<i>Triticum vulgare</i>
Corn	<i>Zea mays</i>
Oats	<i>Avena sativa</i>
Rice	<i>Oryza sativa</i>
Bamboo	<i>Bambusa</i>
Sugar cane	<i>Saccharum officinarum</i>
Barley	<i>Hordeum vulgare</i>
Rye	<i>Secale cereale</i>
Lemon grass	<i>Cymbopogon citrates</i>
Pearl millets	<i>Pennisetum typhoideum</i>
Sudan grass	<i>Sorghum vulgare</i>
Bent grass	<i>Agrostis</i>
Grass	<i>Poa</i>
Tufted grass	<i>Festuca</i>
Venus flower basket	<i>Euplectella</i>
Sea anemone	<i>Actinia</i>
Jelly fish	<i>Aurelia</i>
Portuguese man of war	<i>Physalia</i>
Corals	<i>Medusopora</i>
Tape worm	<i>Taenia solium</i>
Liver fluke	<i>Fasciola hepatica</i>
Blood fluke	<i>Schistoma</i>
Planaria	<i>Dugesia</i>
Roundworm	<i>Ascaris lumbricoides</i>
Pin worm	<i>Enterobius vermicularis</i>
Hook worm	<i>Ancylostoma duodenale</i>
Earthworms	<i>Lumbricus terrestris, Phretima posthuma</i>
Medicinal leech	<i>Hirudo medicinalis</i>
Garden snail	<i>Helix aspersa</i>
Slug	<i>Limax</i>
Marine mussel	<i>Mytilus</i>
Freshwater mussel	<i>Anodonta</i>





## SCIENTIFIC NAMES

Oyster	<i>Ostrea</i>
Squid	<i>Loligo</i>
Cuttle fish	<i>Sepia</i>
Starfish	<i>Asterias</i>
Tautra	<i>Sphenodon</i>
Lizard tailed bird	<i>Archaeopteryx</i>
Spiny ant eater	<i>Echidna</i>
Dodder	<i>Cuscuta</i>
Pitcher plant	<i>Sarracenia purpurea</i>
Venus fly trap	<i>Dionaea muscipula</i>
Sundew	<i>Drosera intermedia</i>
Amoeba	<i>Amoeba proteus</i>
Cockroach	<i>Periplaneta</i>
Digger wasp	<i>Ammophila adrianae</i>
Cocklebur	<i>Xanthium</i>
Tobacco	<i>Chrysanthemum</i>
Henbane	<i>Hyoscyamus niger</i>
Fruitfly	<i>Drosophila melanogaster</i>
Garden pea	<i>Pisum sativa</i>
Cinchona	<i>Cinchona ledgeriana</i>
Rhesus monkey	<i>Macaca mulatta</i>
Black bear	<i>Selenarctos tibetanus</i>
Leopard cat	<i>Felis bengalensis</i>





# SAMPLE PAPER BY KIPS

## MCAT

- (1) Unbroken series of organisms arranged from ancestor to descendant sequence is  
 (a) Biodiversity (b) Phyletic lineage  
 (c) Connecting link (d) Evolutionary line
- (2) Out of total organisms on earth, \_\_\_\_\_ are vascular plants  
 (a) 53.1% (b) 19.9%  
 (c) 17.6% (d) 9.4%
- (3) Control of organisms by using living organisms is called  
 (a) Bioremediation (b) Integrated disease management  
 (c) Antisepsis (d) Biological control
- (4) Branch of biology which deals with the study of chemical components and chemical processes in living organisms is called  
 (a) Molecular biology (b) Physiology  
 (c) Biochemistry (d) Atomic biology
- (5) \_\_\_\_\_ is the potential source of chemical energy for cellular activities  
 (a) C-H bond (b) C-O bond  
 (c) C-N bond (d) P-O-C bond
- (6) Percentage of water in brain cells is  
 (a) 20% (b) 65%  
 (c) 85% (d) 89%
- (7) Breakdown of large molecules into smaller ones utilizing water molecules is  
 (a) Hydration (b) Hydrolysis  
 (c) Dehydration synthesis (d) Electrolysis
- (8) A chemical substance that reacts with enzyme but is not transformed into product and thus blocking active site is called  
 (a) Substrate (b) Co-factor  
 (c) Inhibitor (d) Promotor
- (9) Intake of liquid material by cell membrane is called  
 (a) Endocytosis (b) Exocytosis  
 (c) Phagocytosis (d) Pinocytosis
- (10) Ribosomes were discovered by  
 (a) Golgi (b) De Duve  
 (c) Palade (d) R. Brown
- (11) \_\_\_\_\_ is concerned with cell secretions  
 (a) Endoplasmic reticulum (b) Golgi complex  
 (c) Lysosomes (d) Cell membrane
- (12) Cytoskeleton involved in assembly and disassembly of the spindle during mitosis is of  
 (a) Microtubules (b) Microfilaments  
 (c) Intermediate filaments (d) None of these
- (13) Reverse transcriptase is present in  
 (a) All RNA viruses (b) All DNA viruses  
 (c) All retroviruses (d) All viruses





- (14) Pox viruses are  
 (a) RNA non-enveloped (b) RNA enveloped  
 (c) DNA non-enveloped (d) DNA enveloped
- (15) Bacteria which grow either in the presence or absence of oxygen  
 (a) Aerobic bacteria (b) Anaerobic bacteria  
 (c) Facultative bacteria (d) Microaerophilic
- (16) Destruction of all life forms is called  
 (a) Sterilization (b) Disinfection  
 (c) Antisepsis (d) Preservation
- (17) \_\_\_\_\_ is used to relieve one kind of headache, migraine  
 (a) Pencillin (b) Lovastatin  
 (c) Cyclosporine (d) Ergotin
- (18) The single healthy megaspore retained within the megasporangium germinates to form an egg containing female gametophyte called  
 (a) Ovule (b) Seed  
 (c) Fruit (d) Embryo sac
- (19) Pollen grains in pinus have \_\_\_\_\_ for dispersal through wind  
 (a) Flagella (b) Cilia  
 (c) Wings (d) Feathers
- (20) Double fertilization is feature of  
 (a) Ferns (b) Whisk ferns  
 (c) Gymnosperms (d) Angiosperms
- (21) Alternation of generations is absent in  
 (a) Hydra (b) Obelia  
 (c) Jelly fish (d) Physalia
- (22) Enterobius vermicularis is commonly known as  
 (a) Flatworm (b) Pinworm  
 (c) Hook worm (d) Tapeworm
- (23) Animals of which class of arthropoda are present everywhere  
 (a) Crustacean (b) Insecta  
 (c) Arachnida (d) Myriapoda
- (24) Amphibians are considered to be evolved from  
 (a) Newts (b) Varanope  
 (c) Dipnoi (d) Hagfishes
- (25) Red to orange pigments are  
 (a) Carotenes (b) Carotenoids  
 (c) Xanthophylls (d) Chlorophyll
- (26) NADH is oxidized by  
 (a) Coenzyme Q (b) Cytochrome b  
 (c) Oxygen (d) Glycolysis
- (27) Initial pH of food vacuole during digestion in amoeba is  
 (a) 5.3 (b) 5.6  
 (c) 7.3 (d) 7.6
- (28) Salivary glands present in front of ear are  
 (a) Sublingual (b) Submaxillary  
 (c) Submandibular (d) Parotid
- (29) If bile pigments are prevented from leaving digestive tract, then they cause  
 (a) Hepatitis (b) Jaundice  
 (c) Gall stones (d) Blockage





- (30) How many spiracles are present in cockroach  
 (a) 5 (b) 10  
 (c) 20 (d) 40
- (31) Gaseous exchange in birds occurs at level of  
 (a) Alveoli (b) Air sacs  
 (c) Bronchi (d) Parabronchi
- (32) An infectious disorder of respiratory system is  
 (a) Cancer (b) Asthma  
 (c) Tuberculosis (d) Emphysema
- (33) According to cohesion-tension theory, tension is created by  
 (a) Hydrogen bonding (b) Transpiration  
 (c) Adhesion (d) Root pressure
- (34) Cuticular transpiration is \_\_\_\_\_ of total transpiration  
 (a) 1-2% (b) 3-4%  
 (c) 5-7% (d) 90%
- (35) \_\_\_\_\_ cells of phloem are directly involved in transport of organic solutes  
 (a) Parenchyma (b) Companion cell  
 (c) Tracheid (d) Sieve element
- (36) Deoxygenated blood first enters in \_\_\_\_\_ part in fishes  
 (a) Sinus venosus (b) Right atrium  
 (c) Left atrium (d) Conus arteriosus
- (37) 95% of the cytoplasm of RBCs is  
 (a) Hemoglobin (b) Enzymes  
 (c) Salts (d) Other proteins
- (38) "lubb" sound is produced due to  
 (a) Opening of inlet valve (b) Closure of inlet valve  
 (c) Opening of outlet valve (d) Closure of outlet valve
- (39) An antibody is made of \_\_\_\_\_ polypeptide chains  
 (a) 1 (b) 2  
 (c) 3 (d) 4
- (40) \_\_\_\_\_ of earth surface is covered with water  
 (a) 10% (b) 30%  
 (c) 75% (d) 90%
- (41) Ozone depletion occurs commonly due to  
 (a) Carbon dioxide (b) Chlorofluorocarbons  
 (c) UV rays (d) Deforestation
- (42) The productivity of aquatic ecosystem is basically determined by light and  
 (a) CO<sub>2</sub> (b) O<sub>2</sub>  
 (c) Water (d) Nutrients
- (43) Ecosystem not found in Pakistan is  
 (a) Tropical rain forest (b) Temperate deciduous forest  
 (c) Grassland (d) Tundra
- (44) Annual rainfall in grassland is about  
 (a) More than 2500 mm (b) 750-1500 mm  
 (c) 250-750 mm (d) Less than 250 mm
- (45) Which of the following is most constant abiotic component of ecosystem  
 (a) Air (b) Water  
 (c) Land (d) Gravity



- (46) Conversion of ammonia or ammonium ion into nitrites during nitrogen cycle occurs due to  
 (a) Rhizobium (b) Nitrosomonas  
 (c) Nitrobacter (d) Pseudomonas
- (47) \_\_\_\_\_ supported theory of special creation  
 (a) Linnaeus (b) Aristotle  
 (c) Mendel (d) Lamarck
- (48) In Hardy Weinberg formula  $p^2$  represents frequency of  
 (a) Recessive allele  
 (b) Dominant allele  
 (c) Homozygous dominant individual  
 (d) Homozygous recessive individual
- (49) Humming bird is an example of  
 (a) Cold blooded animal (b) Ectotherm  
 (c) Endotherm (d) Heterotherm
- (50) In condition of high temperature, following does not occur or occurs at low level  
 (a) Vasodilation (b) Activation of sweat glands  
 (c) Thermogenesis (d) Evaporative cooling
- (51) Sapwood is formed from  
 (a) Primary xylem (b) Secondary xylem  
 (c) Primary phloem (d) Secondary phloem
- (52) Number of cervical vertebrae is  
 (a) 5 (b) 7  
 (c) 9 (d) 12
- (53) Joints present in skull are example of  
 (a) Fibrous joints (b) Cartilaginous joints  
 (c) Synovial joints (d) Slightly moveable joints
- (54) Only myosin is present in  
 (a) A band (b) I band  
 (c) H zone (d) Sarcomere
- (55) \_\_\_\_\_ is a nervous disorder characterized by involuntary tremors, diminished motor power and rigidity.  
 (a) Epilepsy (b) Meningitis  
 (c) Alzheimer's disease (d) Parkinson's disease
- (56) Which of the following hormone is polypeptide in nature  
 (a) Insulin (b) Thyroxine  
 (c) ADH (d) Cortisone
- (57) Secretin inhibits production of  
 (a) Gastric juice (b) Pancreatic juice  
 (c) Bile (d) All of these
- (58) Highest form of learning is  
 (a) Latent learning (b) Insight learning  
 (c) Operant conditioning (d) Instinct
- (59) Far-red light promotes flowering in  
 (a) Short day plant (b) Long day plant  
 (c) Day neutral plant (d) None of these
- (60) In human female, fertilization commonly occurs at  
 (a) Proximal part of oviduct (b) Distal part of oviduct  
 (c) Uterus (d) Cervix





- (61) Yellowish glandular structure which produces progesterone is  
(a) Graffian follicle (b) Ovary  
(c) Corpus luteum (d) Placenta
- (62) Yellow cytoplasm in ascidian gives rise to  
(a) Epidermis (b) Muscle cells  
(c) Gut (d) Notochord
- (63) Embryonic induction is caused by part developing from  
(a) Endoderm (b) Ectoderm  
(c) Mesoderm (d) Extraembryonic layers
- (64) Purines and pyrimidines are in equal ratio in DNA. It was indicated by  
(a) F. Miescher (b) Chargaff  
(c) Watson & Crick (d) Harshay & Chase
- (65) Okazaki fragments are connected together through action of  
(a) Primase (b) Polymerase  
(c) Helicase (d) Ligase
- (66) Sickle cell anemia is an example of  
(a) Chromosomal aberration (b) Insertion of gene  
(c) Deletion of gene (d) Point mutation
- (67) Which of the following is an autosomal disorder  
(a) Down's syndrome (b) Klinefelter's syndrome  
(c) Turner's syndrome (d) Jacob's syndrome
- (68) Test cross is used to find  
(a) Trait (b) Phenotype  
(c) Genotype (d) Ratios
- (69) An example of codominance is  
(a) 'A' blood group (b) 'B' blood group  
(c) 'O' blood group (d) 'AB' blood group
- (70) XO-XX pattern of sex determination is present in  
(a) Grasshopper (b) Butterfly  
(c) *Drosophila* (d) Man



## PART-II &amp; SAMPLE PAPER

## CHAPTER-15

1	C	11	D	21	A	31	B	41	A	51	C
2	B	12	B	22	A	32	B	42	C	52	B
3	B	13	D	23	B	33	C	43	D	53	C
4	B	14	C	24	D	34	D	44	D	54	B
5	A	15	C	25	C	35	B	45	A	55	C
6	C	16	B	26	B	36	B	46	C	56	C
7	B	17	B	27	A	37	D	47	D	57	C
8	A	18	D	28	A	38	B	48	D	58	D
9	C	19	D	29	C	39	C	49	B	59	A
10	D	20	C	30	B	40	D	50	C	60	C

## CHAPTER-16

1	D	11	C	21	A	31	C	41	A	51	D	61	B
2	D	12	B	22	C	32	C	42	D	52	C	62	C
3	C	13	A	23	C	33	C	43	A	53	A	63	C
4	A	14	D	24	C	34	A	44	C	54	C	64	B
5	D	15	D	25	B	35	B	45	A	55	B	65	C
6	C	16	B	26	A	36	D	46	A	56	D	66	C
7	B	17	B	27	D	37	B	47	C	57	A	67	B
8	C	18	B	28	A	38	C	48	C	58	B		
9	A	19	C	29	B	39	C	49	C	59	D		
10	B	20	C	30	C	40	C	50	C	60	B		

## CHAPTER-17

1	D	11	C	21	C	31	A	41	B	51	A
2	D	12	D	22	A	32	A	42	A	52	A
3	B	13	D	23	D	33	A	43	B	53	D
4	C	14	C	24	A	34	B	44	D	54	B
5	A	15	A	25	D	35	B	45	B	55	B
6	D	16	B	26	A	36	A	46	B	56	D
7	A	17	B	27	C	37	A	47	B	57	D
8	B	18	C	28	D	38	B	48	B	58	A
9	D	19	A	29	C	39	C	49	C	59	B
10	B	20	C	30	A	40	A	50	C	60	B



## CHAPTER-18

1	B	11	D	21	B	31	B
2	D	12	B	22	A	32	D
3	A	13	C	23	D	33	B
4	A	14	A	24	C	34	B
5	D	15	B	25	C	35	D
6	C	16	B	26	B	36	D
7	D	17	B	27	B	37	D
8	D	18	B	28	D	38	B
9	C	19	C	29	A	39	B
10	B	20	D	30	C	40	C

## CHAPTER-19

1	A	11	D	21	C	31	B	41	C
2	B	12	D	22	B	32	C	42	C
3	D	13	D	23	D	33	C	43	C
4	D	14	B	24	B	34	D	44	B
5	A	15	C	25	C	35	B	45	A
6	B	16	D	26	C	36	A	46	A
7	C	17	D	27	A	37	B	47	B
8	C	18	B	28	C	38	B	48	C
9	B	19	B	29	D	39	C	49	A
10	B	20	A	30	C	40	B	50	A

## CHAPTER-20

1	C	11	C	21	D	31	C
2	A	12	A	22	C	32	B
3	D	13	C	23	D	33	C
4	B	14	B	24	B	34	B
5	B	15	B	25	D	35	C
6	A	16	C	26	B	36	D
7	B	17	D	27	B	37	A
8	C	18	C	28	A	38	C
9	D	19	D	29	D	39	A
10	D	20	B	30	C	40	B





## CHAPTER-21

1	A	11	B	21	D	31	D
2	B	12	D	22	C	32	D
3	A	13	D	23	A	33	B
4	C	14	C	24	C	34	C
5	C	15	C	25	B	35	C
6	D	16	D	26	B	36	D
7	B	17	D	27	C	37	B
8	A	18	A	28	D	38	C
9	C	19	D	29	C	39	C
10	D	20	C	30	A	40	D

## CHAPTER-22

1	D	11	B	21	A	31	B
2	D	12	A	22	A	32	C
3	A	13	D	23	A	33	D
4	C	14	C	24	D	34	B
5	A	15	C	25	D	35	A
6	A	16	B	26	D	36	B
7	C	17	C	27	D	37	C
8	C	18	A	28	C	38	B
9	B	19	A	29	B	39	C
10	A	20	B	30	C	40	B

## CHAPTER-23

1	A	11	C	21	D	31	B
2	B	12	D	22	B	32	D
3	C	13	D	23	A	33	B
4	D	14	B	24	D	34	B
5	B	15	C	25	B	35	C
6	C	16	B	26	D	36	C
7	A	17	D	27	C	37	D
8	A	18	B	28	D	38	A
9	D	19	A	29	D	39	D
10	D	20	C	30	C	40	D





## CHAPTER-24

1	B	11	B	21	A
2	A	12	C	22	D
3	D	13	B	23	A
4	C	14	A	24	C
5	D	15	C	25	D
6	A	16	C	26	A
7	B	17	B	27	C
8	D	18	B	28	D
9	B	19	C	29	A
10	D	20	D	30	D

## CHAPTER-25

1	A	11	C	21	B	31	D
2	C	12	B	22	D	32	A
3	C	13	A	23	C	33	C
4	D	14	C	24	D		
5	B	15	B	25	A		
6	C	16	C	26	C		
7	D	17	B	27	D		
8	D	18	B	28	D		
9	C	19	A	29	C		
10	B	20	C	30	D		

## CHAPTER-26

1	D	11	A	21	B
2	B	12	B	22	C
3	D	13	B	23	C
4	B	14	B	24	D
5	C	15	C		
6	B	16	A		
7	D	17	C		
8	C	18	D		
9	C	19	D		
10	D	20	B		



CHAPTER-27

1	C	11	D	21	A	31	B	41	C
2	B	12	D	22	C	32	D	42	B
3	D	13	C	23	D	33	A	43	D
4	C	14	C	24	D	34	B		
5	A	15	A	25	C	35	C		
6	B	16	B	26	C	36	B		
7	C	17	C	27	B	37	C		
8	B	18	D	28	D	38	D		
9	D	19	B	29	A	39	B		
10	B	20	B	30	D	40	D		

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1	B	11	B	21	A	31	D	41	B	51	B	61	C
2	C	12	A	22	B	32	C	42	D	52	B	62	B
3	D	13	C	23	B	33	B	43	A	53	A	63	C
4	C	14	D	24	C	34	C	44	C	54	C	64	B
5	A	15	C	25	A	35	D	45	D	55	D	65	D
6	C	16	A	26	A	36	A	46	B	56	C	66	D
7	B	17	D	27	B	37	A	47	A	57	A	67	A
8	C	18	D	28	D	38	B	48	C	58	B	68	C
9	D	19	C	29	B	39	D	49	D	59	A	69	D
10	C	20	D	30	C	40	C	50	C	60	A	70	A

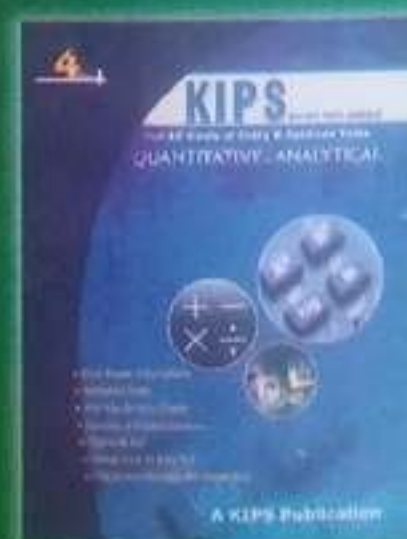
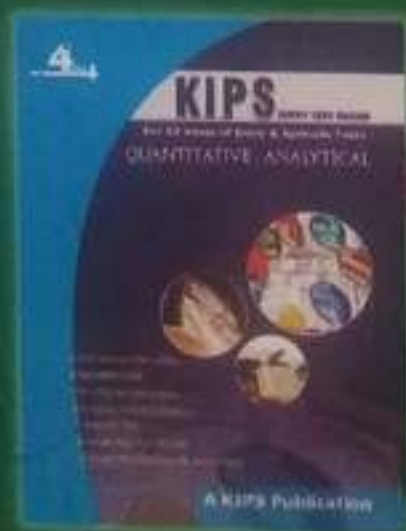
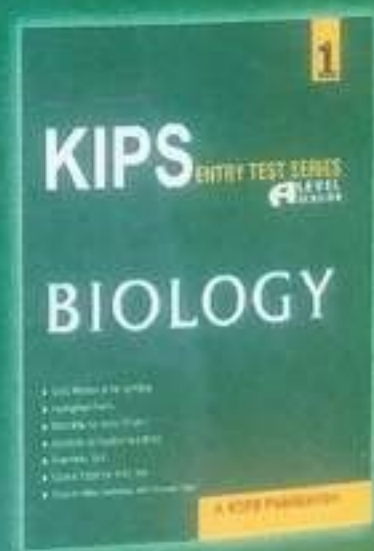
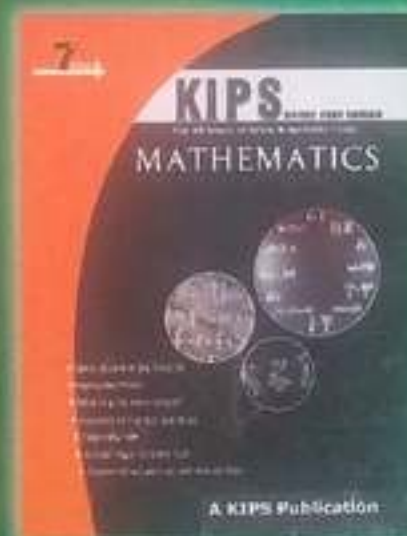
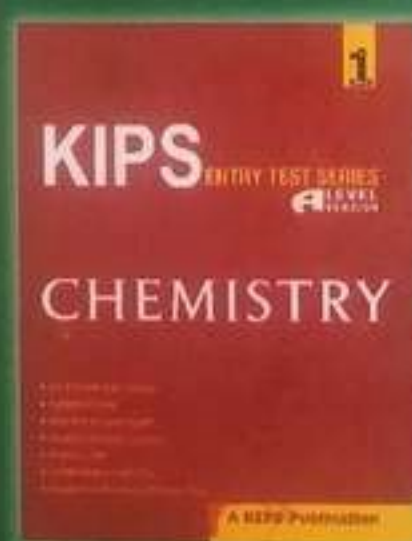
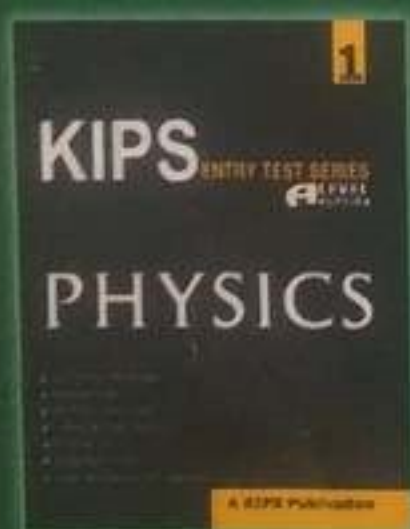
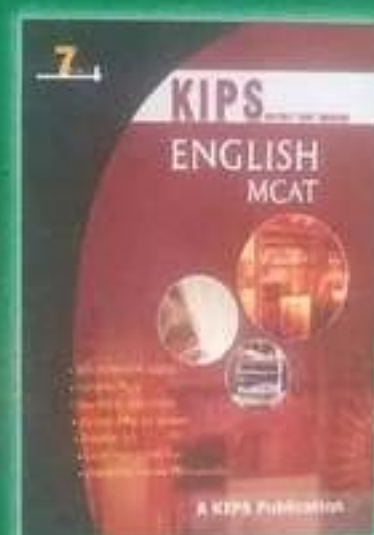
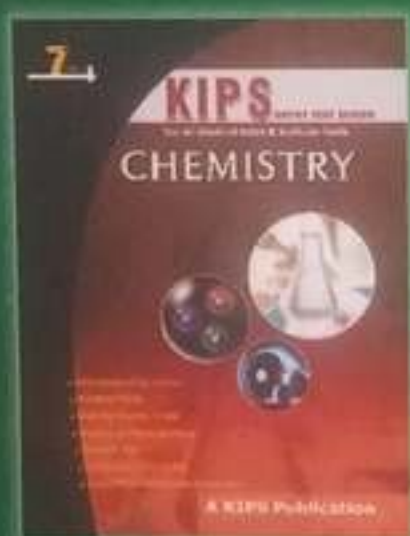
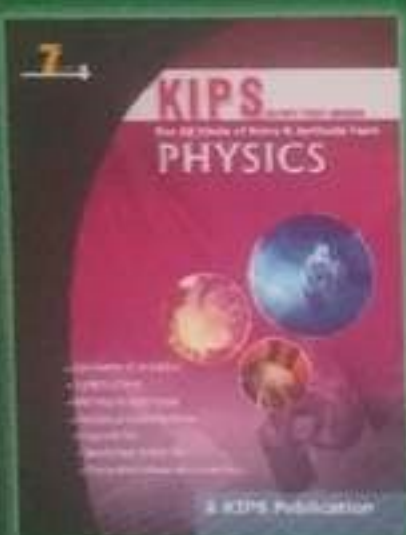


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